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Melt and Anneal Electrically

Eastern Manufacturer Secures Economies by Use of Electrical Apparatus—Steel and Malleable Iron Are Melted in an Arc Furnace and the Resistance Type Is Employed for Annealing Castings

BY HERBERT R. SIMONDS

INTRODUCTION of electrical apparatus in the foundry is largely due to the equipment manufacturers, who have had the double duty of persuading the foundryman to buy and then the electric company to furnish power. Of course this applies only to electric furnaces, which in the early stages of their development produced objectionable surges on the power company's lines. Improvements in design of auxiliary electrical equipment practically have eliminated surges on the outside lines, but there are still some problems to be solved in conection with the furnishing of electric power to operate a furnace in a foundry.

Questions arise as to what voltage the power company is to furnish the customer. The distributing line usually carries 2300 volts or higher, and the furnaces ordinarily are rated at 120 volts or less. If step-down transformers are furnished by the power company, the current is metered on the low side and the losses through the transformers are borne by the power company. If the transformers are furnished by the customer, meters are placed on the higher voltage line and the customer stands the losses. Advantages are evident in both of these plans of metering, but despite the fact that in the second case the customer not only pays for the transformers, but continually pays for the losses through these transformers, this arrangement has so much in its favor that it is almost universal practice today. The use of electric furnaces in general, in foundries still is uncommon enough to give interest to each new installation. Electric furnace companies state that there now are less than 1000 iron and steel furnaces in actual service throughout the entire world. About one-third of this number, or 350, are in the United States. The growth in the use of electric furnaces, however, is shown from the fact that in 1913 there were only 19 furnaces in this country making iron or steel.

One of the most recent additions to

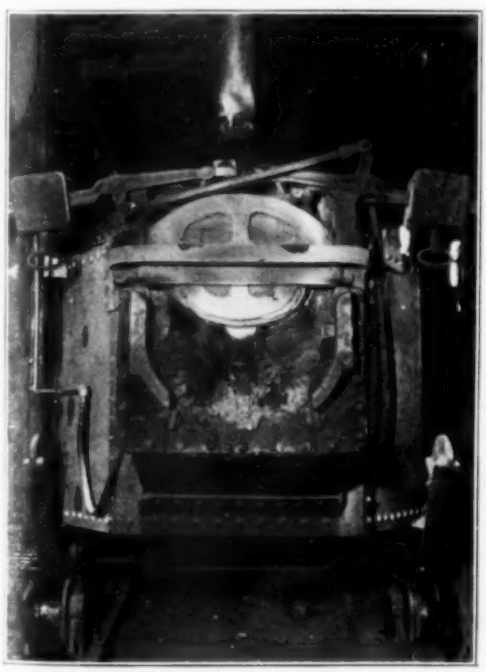

FIG. 1—POURING SIDE OF THE FURNACE—DOOR FURNISHED WITH COOLING COIL

FIG. 2—METAL FROM THE FURNACE IS POURED INTO LARGE LADLES

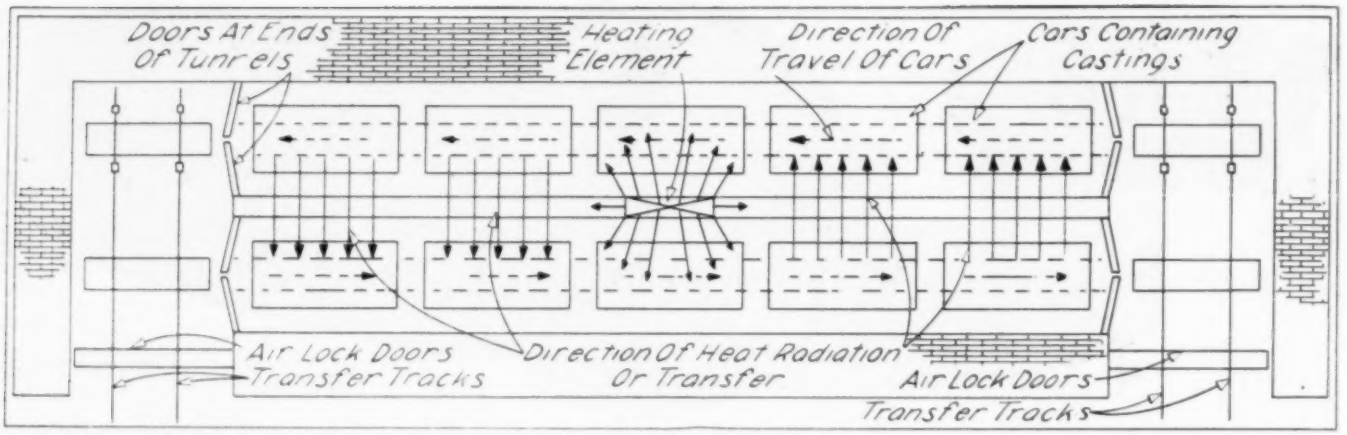
Doors At Ends Of Tunnels
Heating Element
Direction Of Travel Of Cars
Cars Containing Castings
Air Lock Doors Transfer Tracks
Direction Of Heat Radiation Or Transfer
Air Lock Doors Transfer Tracks

FIG. 3—BY HAVING TWO PARALLEL TUNNELS, HEAT FROM THE CASTINGS WHICH ARE COOLING IN ONE TUNNEL IS UTILIZED IN PREHEATING THE UNANNEALED CASTINGS IN THE OTHER

the list of electric furnaces in foundries is the one at the Yale & Towne Mfg. Co., Stamford, Conn. After considerable study of the question, this company installed electrical equipment for making and annealing steel and iron castings. The annealing oven is shown in Fig. 5, and the furnace in Fig. 1. This 1½ ton furnace, manufactured by the Booth Electric Furnace Co., Chicago, is built on rockers which rest on rollers, thus providing an easy means of tilting. The tilting motor, located on the wall side of the furnace, is operated by a push button on the panel. However, should it be necessary, the melter readily can tilt the furnace by means of a hand wheel. Fig 7 shows the arrangement of switchboard and furnace control. The other electrical equipment is in a separate room behind the switchboard.

This and other electric furnaces already have been described, in considerable detail, so that only a few of the outstanding features will be mentioned here. Both the charging and pouring doors are counterbalanced to facilitate operation. The pouring door is water-cooled and both doors are faced up with fire brick. The hearth is elliptical in shape, which makes it possible for the melter's helper to push the slag from the pouring door end, while the melter himself skims off this slag into a pit at the charging door end. The hearth of the furnace at the Yale & Towne foundry is sintered in with magnesite and slag, using about 8 per cent slag. The walls are built of magnesite and silica brick, one row of chrome brick being used for insulation. The roof is of silica splits and wedges, and the electrode openings are of special silica forms which carry pockets to receive the water-cooling coils. A spare roof always is kept at hand in case an accident should happen to the roof when in use. Control of the electrodes is either automatic or by push button from the switchboard. The water-cooled grips for holding the electrodes can be opened and closed from the floor, which entirely overcomes the former occasional necessity of requiring the melter to work from the roof.

ELECTRIC FURNACE REPORT

DATE ... TO ... SIZE OF HEAT ... HEAT NO.
TRANS. TEMP. START ... FINISH ... DEGREES RISE
METER START ... FINISH ... K. W. USED
CONDITION OF ROOF ... LINING ... BOTTOM
NO. OF FIRST HEAT OF PRESENT ROOF ... OF PRESENT LINING
NOS. OF ELECTRODES USED ... NIPPLES USED
POWER ON ... OFF ... TIME ... HEAT TAPPED

METALS	WEIGHT	NON METALS	WEIGHT
SPILLS & SKULLS		GANISTER	
SPRUES		SILICA SAND	
LOCK STOCK		FIRE CLAY	
SKELETON		COKE	
PUNCHINGS		LIME	
TURNINGS		FLUORSPAR	
CHAIN			
FERRO MANGANESE			
FERRO SILICON			
IRON ORE			
ALUMINUM			
TOTAL		TOTAL	

REMARKS:

HEAT ANALYSIS

	CARBON	SILICON	MANGANESE	PHOSPHORUS	SULPHUR
SPECIFICATIONS					
PRELIMINARY					
PRELIMINARY					
FINAL					

MELTER

FIG. 4—BEFORE EACH HEAT, A CHARGE SHEET IS MADE OUT GIVING A LIST OF THE VARIOUS ELEMENTS REQUIRED AND OTHER DATA

The operation of an electric furnace in a foundry is largely a question for each melter to work out for himself. The practice in any one plant, however, furnishes a guide for that in other plants. At the Yale & Towne foundry the operation centers about a form such as shown in Fig. 4, which is figured out by the melter previous to each charge. The various elements required are estimated from previous chemical analyses of the backstock and scrap to be used in the heat. The charge consists of 40 to 45 per cent backstock, the balance being made up of scrap. The furnace is charged at the rear end of charging door, the heavy pieces being put in first, and the lighter material used to fill up the spaces and openings. When the charging has been completed the three electrodes are lowered by means of push buttons until within an inch of touching the charge. The doors then are closed and all valves for the water cooling devices opened. When this is done and the furnace is otherwise seen to be in readiness, the switches for the automatic feed for the electrode are closed. Immediately the electrodes begin to feed downward until they come in contact with the charge. From this point until the first sample is taken, the melter exercises no control over the furnace operation except that he keeps his attention on the volt and ammeters, from which instruments irregularities can be detected quickly. Occasionally loose pieces of scrap may be raked in to help the bath in the molten state. As soon as the charge is melted, a sample bar is cast for the carbon analysis. To make this test bar, a cast steel spoon first is dipped in the slag on top of the steel until it is completely coated. This is done to prevent the steel from skulling in the spoon and sticking to it. The spoon then is inverted and forced down into the bath, turned upright again and brought out with the sample of steel in it. The test bar itself is cast in a sand mold to prevent chilling. As

soon as possible samples from this bar are hurried to the chemical laboratory and the results of the carbon analysis are back to the melter's in approximately 10 minutes.

One detail to consider in connection with this analysis is guarding against particles of sand being included with the sample and thus throwing off the results. By carefully picking up the borings with a magnet, this danger is overcome.

Immediately after taking the first test the melter pulls the phosphorus slag. He cannot afford to lose any time at this moment as the phosphorus goes into the slag at a relatively low temperature and the action is reversed if the bath becomes too hot. The sulphur slag now is added and from here on the metal is in a reducing condition. To help maintain this condition often it is desirable to scatter coke breeze over the slag at short intervals. When the metal has reached something near the pouring temperature, the melter takes a further test for carbon and manganese. At this time a temperature test also is made. This latter is done by snapping a stop watch as the spoon comes out of the bath and then observing it for a film covering to appear on top of the sample. The time interval in this determination of course depends upon individual conditions. However, with given conditions a definite time for film covering to appear indicates within a narrow range the temperature of the iron. At the Yale & Towne foundry, should the film appear in 30 seconds, the steel is known to be cool and the heat is continued until the film appears in 50 to 55 seconds.

During the alloted time, the final analysis is made and the results are in the hands of the melter in time to make any necessary ferroalloy additions, after which the steel is poured. The pouring operation is shown in Fig 2.

The furnace just described is used for making steel and malleable iron castings. A large part of these must be annealed and this also is done electrically. The castings, most of which are small, are picked up from the foundry floor and placed in steel trays as shown in Figs. 5 and 6. These trays are designed to permit both radiation and circulation of air currents below and between them. The trays are collected by small electric hoist trucks as shown in Fig. 6, and are carried directly to the annealing oven.

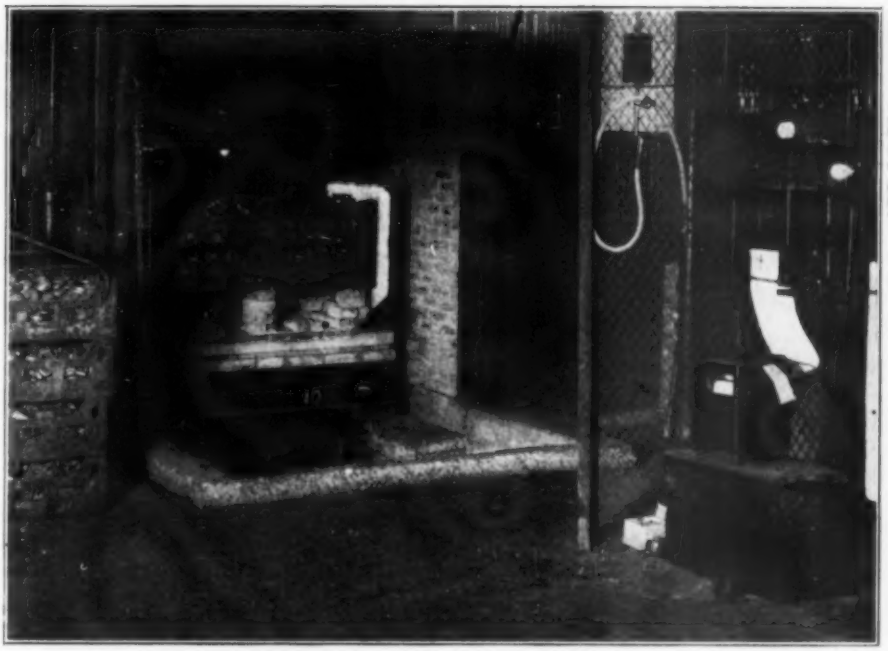

FIG. 6—ONE END OF THE ANNEALING OVEN SHOWING CAR ON THE TRANSFER TABLE. AT THE LEFT ARE THE TRAYS OF UNANNEALED CASTINGS

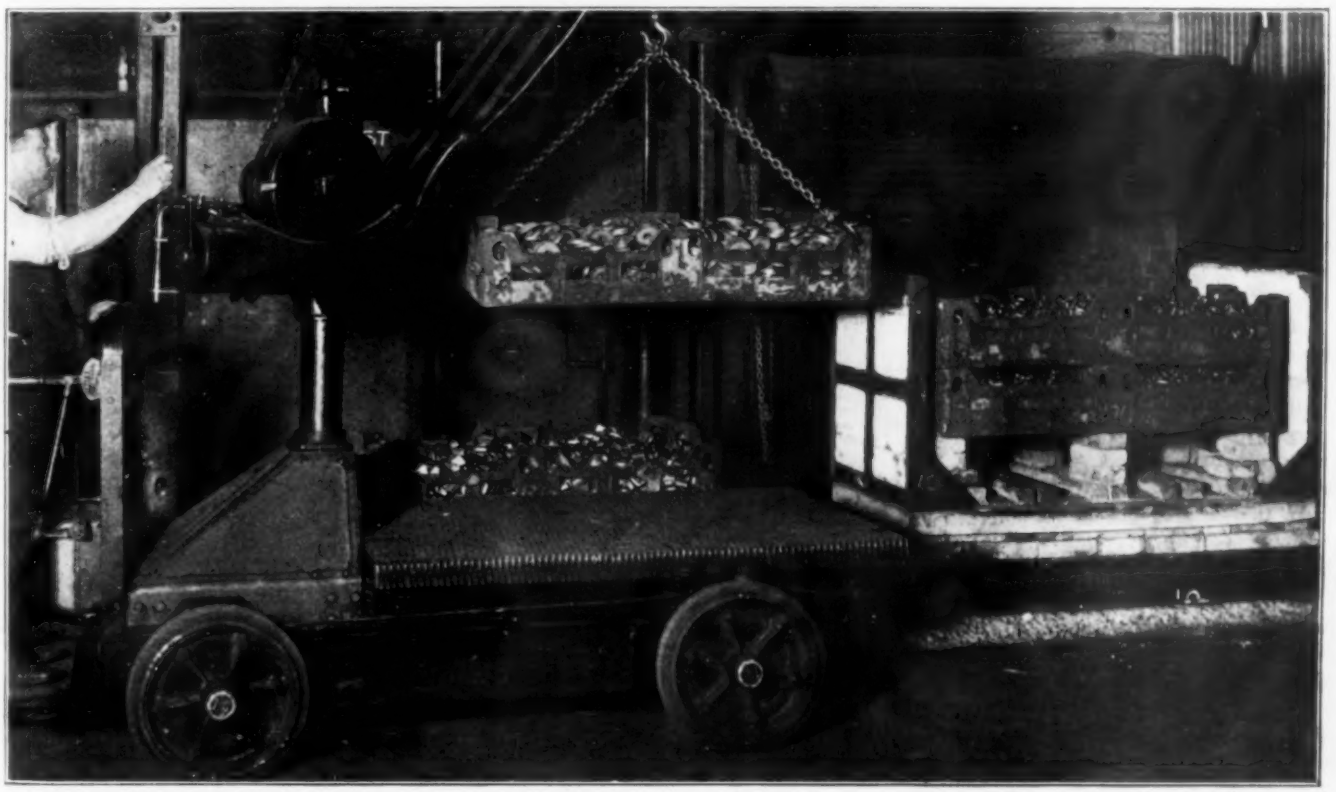

FIG. 5—CASTINGS ARE BROUGHT TO THE ANNEALING OVENS ON SMALL ELECTRIC TRUCKS EQUIPPED WITH HOISTS

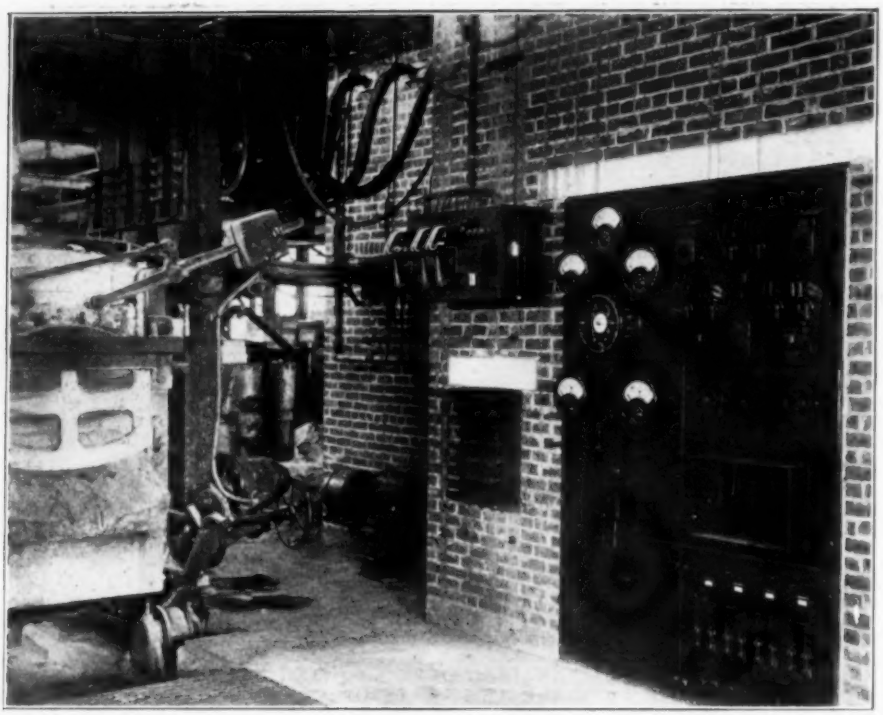

FIG. 7—THE SWITCHBOARD IS CONVENIENTLY LOCATED AND THE FLOOR SPACE IS UNOBSTRUCTED

The operation of this oven is somewhat unusual and a description of its general construction will be necessary before the cycle can be explained. The oven is manufactured by the Electric Furnace Construction Co., Philadelphia, and is equipped with General Electric Co., Schenectady, N. Y., nichrome registers, giving an annealing capacity of 20 tons per 24 hours at a temperature of 1450 degrees Fahr. The oven unit consists of two parallel tunnels each equipped with tracks. Cars travel in opposite directions in the two tunnels. Five cars are located in each tunnel and the heating elements are situated on the walls opposite the middle car only. An air lock is provided at each end of the tunnels outside of the main doors to prevent circulation of air when the furnace doors are raised for shifting the cars. An extra car is provided so that it may be loaded or unloaded while the furnace has both tunnels in full operation. Transfer tables are installed at both ends of the parallel tunnels. By having the direction of travel opposite in the two tunnels, advantage is taken of the heat given off from the castings during cooling. A description of the operation will show this.

The steel trays loaded with castings to be annealed are stacked three high on the small cars which operate in the oven. Assuming that both tunnels are loaded, the procedure is for the extra car to be loaded and pushed into the air lock to a point opposite the entrance to one of the tunnels. The air lock then is closed. The tunnel door is raised and the car pushed into the tunnel by a motor-driven screw pusher which pushes a car out of the other end of the tunnel to the transfer table, and incidentally moves all of the cars up one stage. The movement is called a shift, these are made normally every hour, first in one tunnel and then in the other. The car which is forced onto the transfer table is removed from the air lock, unloaded and reloaded with annealed castings and then is ready for the next shift which as has been stated is in the other tunnel and in the opposite direction. From this it will be seen that the cold cars entering the furnace stand for several hours opposite the hot cars of annealed castings which are cooling in the adjacent tunnel. In this way much of this heat is absorbed which otherwise would be wasted. By making one shift per hour, first in one tunnel, and then the other, each car is allowed to remain two hours in each position. Four hours therefore is

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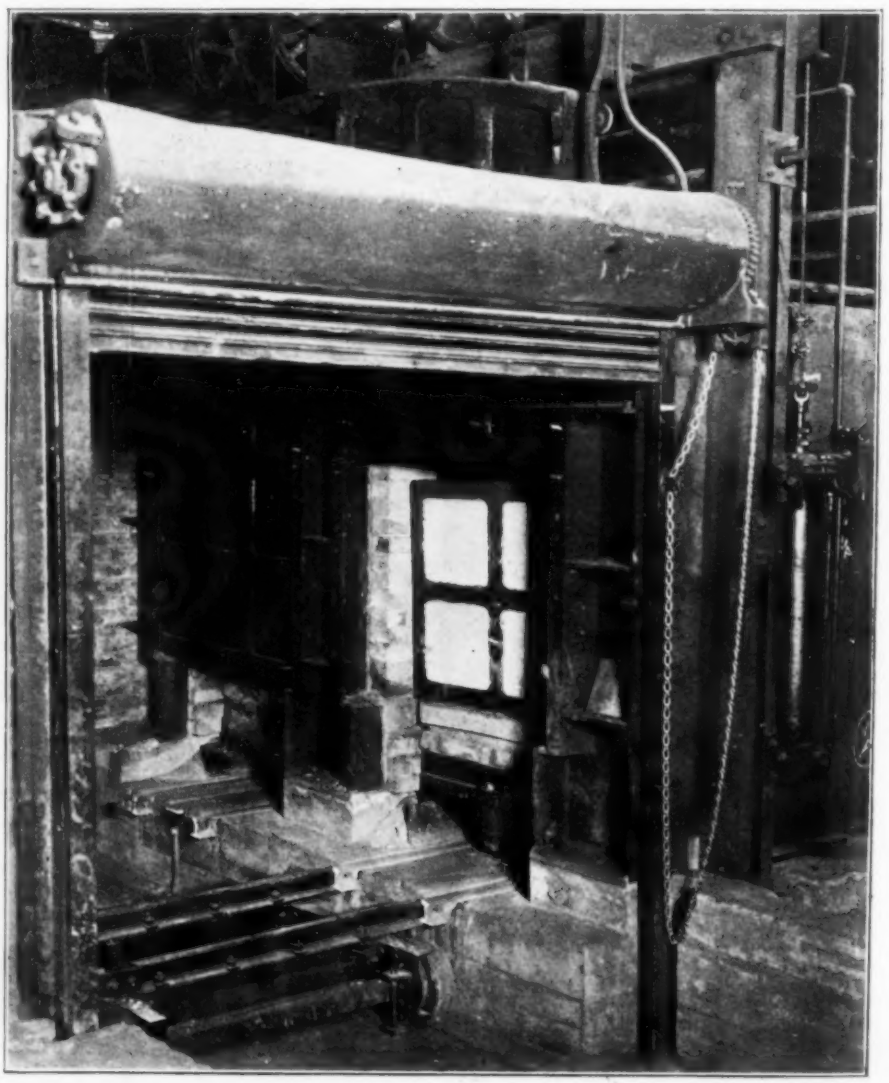


FIG. 8—A VIEW ACROSS THE TRANSFER TABLE SHOWING THE ENDS OF BOTH TUNNELS. THE AIR LOCK CURTAIN IS IN THE FOREGROUND

Ignorance Causes Depression

Enlightenment Regarding Business Conditions and Laws Would Lessen Depressions—Management of Modern Industry Should Familiarize Itself with Basic Factors Regarding the Industry and Exchange Information

BY ERNEST F. DUBRIL

DEPRESSIONS are of very keen interest to everyone, because every element of our industrial system is affected by them. The largest element, in number, is the farming element, and nearly as large, is the wage earning element. When a depression is at its worst, there is great despondency all over the country, and when it is over, many who have been set back by it are left with a very dull outlook indeed.

To the wage earners, a depression brings the most suffering. Jobs are scarce and wages are low. If lucky enough to have jobs, some men are perhaps overdriven when they are at work. If without a job the haunting fear of poverty gnaws at their souls. What wonder then, that in times of depression the wage earner's troubles make him very receptive to every promise of a glib-tongued radical who pictures a golden future of ease and comfort?

Farmers and business men face losses, not only of paper profits, but of real wealth previously accumulated. Many of them go down in failure, never to rise again in the financial scale, to a position of independence. What wonder that they, too, give sympathetic ear to political quacks who with promises of cheap money and cheap credit would make these men believe that their troubles are to be easily ended, if only the quack is put in the political saddle? Necessarily because the prevention of depressions would be of tremendous benefit to millions of our people, this subject is well worth consideration by everyone.

Everyone recognizes a depression as being an evil, a condition of business ill health—a sort of economic disease—and as in cases of bodily disease all desire both cure and prevention. No modern physician attempts merely to treat symptoms of ill health. Medical progress has shown that the physician must get down to the real cause of a disease before he can intelligently treat it.

Yet no matter how much the doctors may learn about disease, its cause, its cure, and its prevention, their knowledge will be of little help unless and until it becomes spread among the people. The patient or the potential victim of disease must play his part in the cure, and more so in the prevention of diseases of the human body.

So, too, with the economic disease of industrial depressions. Human beings of every rank and walk in life are both causes and victims of these depressions, and neither cure nor prevention can be expected until the mass recognizes the causes and co-operates in prevention. As a mass, humanity does not yet know enough about the causes to take preventive measures. Nor does the average business man seem to care enough about the subject to get down to hard study, and to keep his own house in order. Here and there a few men have been doing their utmost to conscientiously keep their own business sound, in the light of information so far available. But most business men seem to prefer to let things drift, and then they want to blame the Federal Reserve bank or a buyers' strike, or the labor unions, or sun spots, or anyone or anything but themselves—for the losses they and their employes suffer.

Just as diseases of the body are personal to the individual, so financial disease is personal to individual concerns. A community is weakened in which many persons are afflicted with typhoid, yellow fever, or hookworm, because the sick not only cannot look after themselves, but they require attention from the healthy. So in business, the concerns that are individually unhealthy are a drain on the community because the healthy are deprived of a market that would otherwise be offered by those who have fallen victims to financial or commercial disease.

Business men, as a mass, have not yet learned that the business structure of the whole world is essentially one co-ordinated, co-operative machine for the supply of human wants. Too many business men—and politicians—look upon business as a species of warfare—of a struggle without mercy in which the battle belongs of right to the strongest and in which rules for fair play are considered mere interference with the necessary conduct of the combatants. Such men have not received the broader vision that all business is co-operative and constructive, not combative and destructive. True, each one of us must find for himself the place in the system where he can best function. No superman can tell us where that place is—in spite of the socialist's dream to the contrary. As long as society is organized under the principle of individual liberty, we must each run our own jobs, and do that in the light of the best knowledge available.

Too few people are prepared to challenge the complacency of management, and its persistence in avoidable ignorance. Depressions are business phenomena. Business is a purely human activity, and therefore depressions caused by human beings are not by acts of God, sunspots,

Managers Must Study Business Trends

THE fundamental cause of depressions is that too many business executives are woefully—perhaps willfully—ignorant of some very important phases of their jobs as managers. Management must learn the lessons of how to prevent depressions or society may try the foolish attempt to manage things by collective action. Enough dissatisfaction now exists without increasing it by supine indifference. It is the main job of management to forecast the future, just as well as possible. On that job, management has made rather a rank failure. Every industry can have effective means of estimating supply and demand. But ignorantly selfish management can neither grasp its value nor use it intelligently. Supply and demand can be gaged only by co-operative study, statistical compilation and interpretation of the various cyclical movements as they develop in each industry. Few managers would know how to guide their policies intelligently even if the statistics were available in their own fields. They need educating and many need the first requisite, the willingness to learn. Few managers as yet realize that the study of cyclical movements in interdependent industries well repays the time and money spent. As a consequence of ignorance we have the losses caused by overstocking with high priced material or product in face of falling demand.—Author

Paper read before the American Foundrymen's association meeting, Rochester, N. Y., June 7, 1922. The author is general manager of the National Machine Tool Builders association, Cincinnati.

or any other extraneous force apart from business men themselves.

Which element in business is most responsible? How about the investor? In big business, the investor has precious little to say about the conduct of the business that is using his capital. Is it the production department? Its staff produce or not as they get orders to act, from a superior authority. Is it the sales force? They can't squeeze the life blood of orders out of a dead market. There then remains only one other element, the one that holds the final authority, the entrepreneur element as represented by the management, the elements in short, that dictates the policy of a business.

Depressions are ultimately due to maladjustment between supply and demand—and these maladjustments occur because those responsible for supply know too little about either supply or demand to be able to make the adjustment that is needed. Demand is the fickle mistress whose behests must be obeyed. So that those responsible for supply should know as much as possible about the course of demand in order to make the necessary adjustments. But what do they know? How many know anything about demand in general for their own specific products, except as they meet it in their own business? How many foundrymen have really studied the course of the pig iron market for which they have had charts and statistics for years past?

How many of them know that for years past the discount rate of 4 to 6 months commercial paper has predicted the course of pig iron prices and production about 5 months in advance, with uncanny accuracy? How many blast furnacemen knew this and if they did, how many tried to spread their knowledge to others so that it would save the iron business from the losses of depression? How many foundrymen have known that a statistical service could be organized among them that would indicate far in advance when the blast furnace could start in anticipation of actual melting of iron for castings? If this were done, there would be less shortage of iron and less consequent skyrocketing of prices at the peak of demand.

Statistics Are Helpful

A complete statistical compilation of new orders, cancellations and suspensions, production and shipments, stocks on hand and unfilled orders, by grades would give the foundry iron producers a wonderful picture of the state of supply and demand in that business. But not all producers will report those figures to their own association. Those figures would be wonderfully helpful to the producers themselves if they were published where all buyers could use them. In such cases public comment would be made on the significance of different phases.

Buyers and sellers alike would be able to run their business more intelligently and the furnaces would consequently have much more regular operation than now. But when will the furnaces give out the complete figures? When will the furnacemen all realize that it is against their interest to overload buyers with high-priced pig iron? And when will all foundrymen get sense enough to stay out of a runaway iron market and not fall for the iron salesman's bunk talk of why prices can never come down again? When will furnacemen cease building more furnaces than the country ought to have? I guess it will be when the foundrymen learn that it is dangerous to speculate on iron. When both of these elements have learned those little lessons, probably other business men will have learned theirs and then depressions will be prevented, but hardly before.

Of course, gathering information without using it would be a childish waste of effort and money. There is a lot to be learned about the significance to different phases of business cycles—how they develop and why, what things to do and what not to do in different stages of a cycle. Yet this knowledge is not difficult to acquire. Practical business men with fundamental training in economic theory are not very plentiful, it is true. But practical foundrymen with a training in chemistry were not very plentiful either, a generation ago. There seem to have been very few in the cast iron pipe business during the nineties. But foundrymen got to know the application of chemistry to their business, and some good business men are getting to know the application of economics to theirs.

Consulting economists are becoming as recognized professionally as consulting chemists or consulting engineers of various kinds. The consulting economist who knows his work can read the business weather signs fairly well, and is getting to read them better every year. The analytical economist is learning the causes of depression and the consulting economist is advising his clients how to avoid disaster by getting out from the path of the impending avalanche. Both of them watch the development of a cycle, and by analytical statistical study of previous cycles they know the signs. Their offices are becoming well recognized as business weather bureaus. They know that over-booming breeds depression and they warn their clients and employers well in advance. The trouble even yet is that many business men who had ample warning did not believe in the signs because their education in economic theory had been sadly neglected. They thought that the war conditions somehow had changed the fundamentals, but human nature does not change, and economic forces based on fundamental human nature worked out as always, and over-booming brought a depression.

Even though business men know that over-booming at one time is sure to cause depression later, how many of them will learn to restrain their optimism and reef sail before the storm is so strong upon them it is too late? A ship captain can now be warned by radiophone that a storm is close at hand. What would you think of his judgment if he neglected weather reports, depending only on his own lookout, and persisted in carrying full sail till the moment the storm broke, thereby losing ship and cargo? Yet many a business captain excused his own ignorance that has been as reckless.

Many Reports Help

With the radio available, would we think a captain or ship owner competent who would not equip his vessel to at least receive reports? Do we not expect every large ship to use every means to better the weather service on the sea, to report to shore the state of weather in its own location, and have the shore stations make up weather maps from all available reports and then send back to the ship at sea their prediction for the next few hours? This is co-operation of the right kind. The same sort of thing can, and should be done in business. The more reports that are gotten, industry by industry, the better weather maps of business will be drawn, and the better will business forecasting become.

Unfortunately, too many people are placing a child-like trust in average lines, drawn as composite curves, from data that has no logical connection. Averages conceal facts. We have to make different curves for different lines of business to get at true conditions in these different lines. Some precede, others lap in rise or decline of their demand. Some demands are much more constant than others. Some very important industries, particularly the metalworking industries and the construction and equipment industries have much sharper peaks and longer and deeper depressions than the food industries. A clothing industry's curve is quite different from a food industry's curve of activity. Heavy machine tools show quite different curves from light machines and small tools show curves entirely different from either.

One who wishes closely to estimate his demand cannot depend on some general composite average curve or chart, any more than the sea captain could depend on an average curve of wind velocity. A dead calm in one place and a 50-mile hurricane in another would av-

erage 25 miles. But a ship captain in the calm and another in the hurricane belt would each have different problems from a third in a 25-mile breeze. The becalmed sailor would be mighty anxious to know when a breeze was heading his way, while the storm tossed mariner would be mighty anxious to know when the wind would die down, and they might not be very far from each other at that. In between, the captain clipping along with the good breeze would want to know whether to look for a calm or a storm, and how soon.

The weather bureau ashore can tell them all what they want to know if enough of them report their own weather back to short first; so, too, with weather service for business. Let enough industries report the course of demand and supply from month to month, later on from week to week and the observers of the business weather service will be able to predict from the past what is likely to happen in different zones in the near future. By observing, and by recording, compiling and comparing observations even the currents of the air are becoming well enough known to be charted, just as are the currents of the sea. All this is done for just a small branch of business,—navigation. Why should we not do something similar for other important parts of business?

Must Destroy Ignorance

If "knowledge is power" then ignorance is weakness. Why be content with the weakness of ignorance when we can have the power of knowledge, at less cost than the sums we now waste through ignorance?

To err is human—and it is precisely because so many do the wrong thing for a given time in business that we have the extremes of boom that cause depressions later. If, when the next era of prosperity develops, there are more men who have learned how and why to guide their policy sanely, if there are more men of knowledge who also have the will power to resist the temptation to extravagance and over-expansion, there will be that much less wild inflation, and less over-ordering and cancellation, less overselling and failure to deliver, less over-borrowing and failure to pay.

Let us have more industry statistics of the right sort. Let us publish them where all may read and interpret them. Let us have more study by business men of the real workings of that law of supply and demand that so many talk about and so few understand. Let us realize that economics and statistics are real scientific tools to be used, and not scorned by business men. Then we shall have better business, and we shall more surely reach the goal of all business. Profits must on the whole be sufficient to reward men for undertaking production. But it is not to the interest of the public that such profits be gained only in hurricane days in great enough volume to repay the business man for long periods of idleness. The risk is too great for the reward.

To use a phrase from the power engineers' handbook, many businesses have a bad "load factor," and besides, many of them are even excessive in equipment compared to their greatest peak load. This is social waste of capital. Every step that can be taken to stabilize, or regularize the load means that much less waste of capital. By reducing wasteful investment, more capital would be free to supply additional wants. As it is now, the investor hears of the big profits of boom times, but the promoter conveniently forgets to mention the losses of depression. Losses do not add to the glamor of a prospectus, but they certainly bring down returns to an average that society on the whole must pay to get its work done. If the earnings of some businesses in some years were not so big, their losses of some other years would not be so big. The big profits of some years tempt investment in excess plant, and with a slackening of demand the excess plant competes for business on a cut-throat basis, with loss to all.

If our industries were all perfectly frank in publicity of supply and demand, cost and profits, capital investment could be made on a sane basis, and competition would better take care of the supplying of human wants at fair prices that would be steady.

The economist's abstract concept of a theoretically perfect market necessarily presupposes a fully informed market, in which all buyers and all sellers will know the exact state of the market. Then only can competition work out the fairest price Those who, through mistaken ideas of selfish advantage, refuse to make the disclosure necessary simply encourage the dreamers to devise something in the way of socialism that would surely ruin industry and society itself. Russia should be example enough for us all. Let us not live in a fool's paradise, dreaming that such things cannot happen in the United States. If business men will not see the need of getting down to prevention of industrial woes, it need not surprise us if the ill-informed voter should insist on trying his hand at the job the business man should have done. Many misguided radicals are continually egging the ignorant voter on to do that very thing.

Business efficiency has been put to its defense. It has no excuse for further delay in studying the disease and the remedy, both of which have been indicated by economists for some years past. The final answer is in the hands of business men, and theirs is the final responsibility for a proper solution.

Book Review

Electro-Metallurgy of Steel, by C. C. Gow; cloth, 350 pages, 5½ x 8½ inches; published by D. Van Nostrand Co., New York, and for sale by THE FOUNDRY, price $7.50 postpaid.

This book has been prompted by the rapid development within recent years of the electric furnace for steelmaking. Prior to the outbreak of the war the electric furnace had only a limited application. However, the shortage of high grade raw materials, the enormous demand for alloy steels and the great accumulation of heavy steel turnings during the period of the war, presented exceptional opportunities for development of electric methods in steelmaking. Since that time many modifications have been made in the manner of utilizing electric energy in arc furnaces and a much clearer understanding of the chemical reactions peculiar to the processes in these furnaces has resulted. Although both arc and induction furnaces are discussed, the author has studied more especially the electrothermic processes of steelmaking in their relation to arc furnaces which produce almost the entire output of electric steel.

Since chemical and electrical conditions are mutually dependent upon one another it is impossible without a knowledge of the general principles underlying the use of alternating currents for arc heating to know whether a slight adjustment of the electrical or the chemical conditions is required to remedy an unsatisfactory state of either. Three chapters are devoted to the general principles and application of alternating currents, the material being presented in a manner easily understandable to those without mathematical or other special knowledge. Another chapter deals with the factors bearing upon the cost and economic use of electric energy to show how the maximum economy of power may be obtained.

No definte figures have been given bearing upon the cost of steel production as governed by factors other than the actual cost of power, raw materials and labor. The author emphasizes throughout the book the fact that such important factors as power consumption, life of linings and the electrode consumption are not only all interdependent for any given type of furnace but are absolutely controlled by the furnace load factor and the precise nature of the processes used. For these reasons even comparative costs are dangerous and misleading without stating the exact conditions of operation in each case. The book is divided into 25 chapters and an appendix and is well illustrated with more than 130 photographs, sketches and charts.

Making Flexible Jointed Pipe

In Many Respects the Methods Are the Same as Employed in Molding Straight Lengths, Except in the Top Flask Section for the Spigot End

BY W. G. HAMMERSTROM

FLEXIBLE water pipe joint differs from the ordinary bell and spigot and flanged joints in that, as the name implies, it is flexible, which means that the joint may be deflected several degrees without leakage. This deflection feature is necessary to facilitate laying the pipe underneath rivers, in comparatively deep water and in places where the material surrounding the pipe is liable to settle unevenly and to a greater or less degree after the pipe line has been laid. Several of these lines have been completed in various parts of the country including one 24 inches in diameter, 15,000 feet long crossing Lake Champlain, N. Y., and a larger line 36 inches diameter conveying New York's Catskill water supply underneath the Narrows from Brooklyn to Staten Island. The Lynchburg Foundry Co., Lynchburg, Va., recently has supplied the city of Norfolk, Va., with a considerable tonnage of 30-inch flexible joint cast iron water pipe. This pipe forms part of a 20-mile pipe line conveying water from the reservoir to the city and is laid where the line crosses the Nansemond and Elizabeth rivers.

Based on Ward Joint

A great variety of designs for flexible jointed water pipe are on record, but none differs to any extent from the original Ward joint, patented by John F. Ward in 1863. The 30-inch pipe selected by the City of Norfolk is a modified type of the Ward joint, a sectional view of which is shown in Fig. 8. The spigot end is machined to form a section of a perfect sphere with a radius of 18¼ inches and is finished carefully to gage. A shoulder cast integrally provides a definite stop at maximum deflection of the pipe without injury to the lead at the face of the bell. The inside of the bell is provided with a ring which serves the double purpose of holding the lead and of centering the pipe to insure a uniform lead space. This ring is machined to the same radius as the spigot. A steel band 1 x 4 inches is shrunk on the outside of the bell end to protect it from breakage in handling and transportation. The pipe is made in 12 foot lengths and has a body thickness of 1.37-inches, corresponding to class *D*, American Water Works association standard.

Heavy Flasks Employed

The equipment for making the mold and the manner in which it is assembled, is shown in Fig. 2; the left hand view showing the mold as it appears with the casting in place and the right hand view showing the mold rammed with the pattern still in place. The iron flask is made up of four carefully machined main sections: two straight body sections and two specially flared sections, one for the bell at the bottom and one for the spigot at the top. Each section is made in halves to facilitate shaking out the casting. The halves for the straight sections are held together permanently at one side by heavy hinges and on the other side by substantial steel clamps and wedges. The rugged construction of the flasks may be noted in Figs. 1 and 3. They receive a great deal

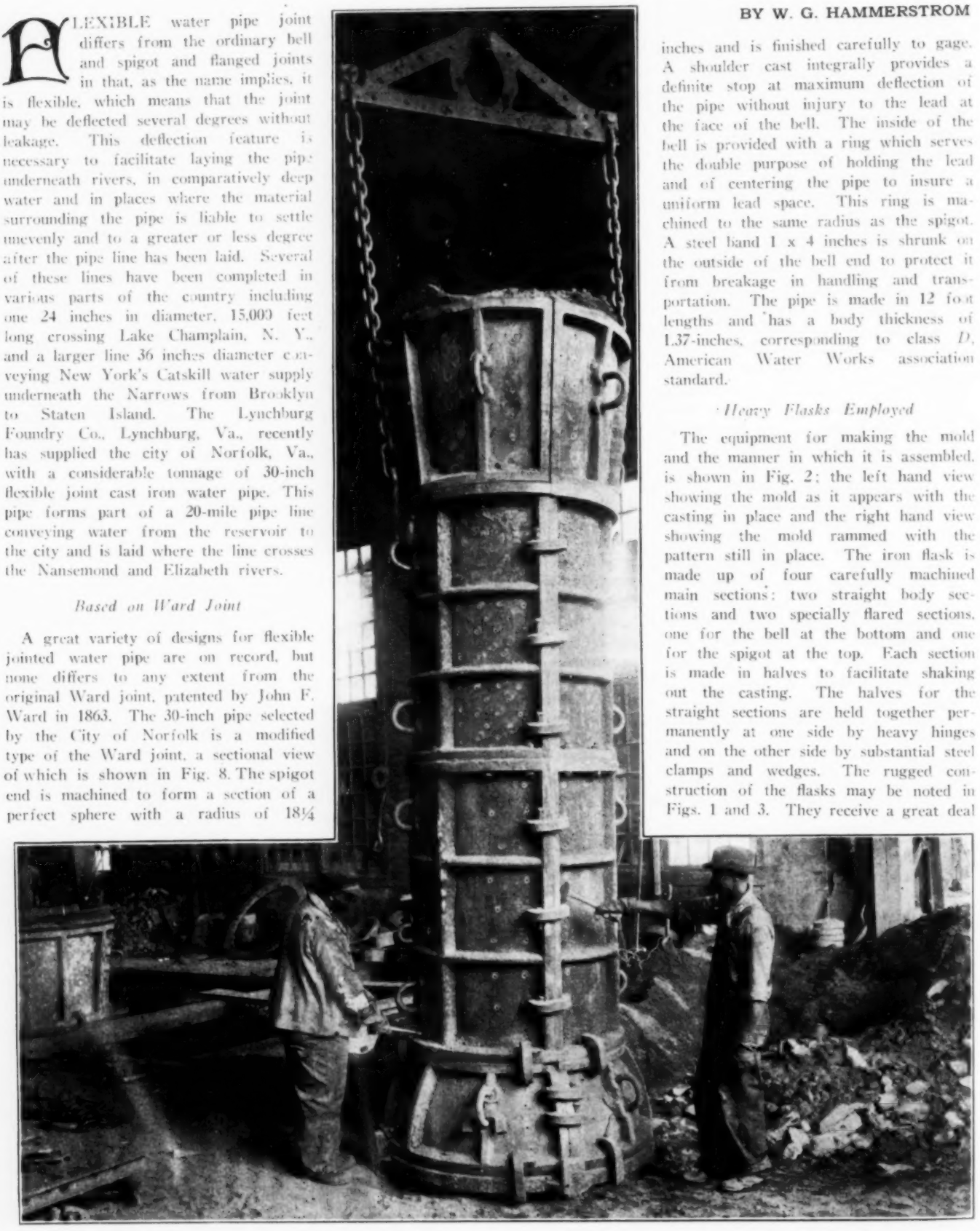


FIG. 1—AFTER THE FLASK IS LIFTED OUT OF THE PIT THE TOP AND BOTTOM SECTIONS ARE RELEASED, THEN IT IS LOWERED TO A HORIZONTAL POSITION AND PLACED ON SKIDS WHERE THE CASTING IS ROLLED OUT

of rough handling and this type of construction effectively prevents costly renewals. Steel loops with the ends anchored in heavy bosses on the sides of the flasks serve as handles for lifting the flasks into and out of the casting pit, for shaking them out and for reassembling them afterward.

The pattern equipment for making a pipe is shown to the right of Fig. 2. Taking the parts in order and commencing at the bottom, *A* is the head pattern which forms the outside of the bell. *B* is the body pattern for forming the straight section of the pipe and *C* is the spigot pattern which is made separately and slides down over the body pattern. The head pattern is bolted to the ramming stool *D* and the lower end or the body pattern fits into a turned joint as shown at *M*. One of the head patterns attached to a ramming stool and with the lifting ring in place is shown in Fig. 4 at the extreme left.

Ramming the Mold

The stool with head pattern attached is adjusted level and the lifting ring 1 inch thick shown at *E* in Figs. 2 and 3 is lowered into place. The bell pattern is 1 inch longer than the casting to compensate for the thickness of the lifting ring. This ring serves as a stripping plate and insures a clean lift when the flask containing the sand is lifted away from the pattern. The bell section of the flask is set on, clamped to the ramming stool, filled with sand and rammed. The straight sections of the flask then are set on and clamped to the bell section. The body of the pattern is lowered into place where the lower end automatically centers and adjusts itself on the seat provided in the head pattern *M* Fig. 2. Sand is shoveled and rammed around the pattern until the 1½-inch space is filled to the top of the straight sections of the flask. The spigot end of the flask is set on and clamped to the top flange of the straight section after which the spigot extension of the pattern, *C* Fig. 2 is slipped down over the body pattern until the upper surface is flush with the top flange face of the flask. After the entire flask is rammed full of sand, the upper surface is scraped off flush to serve as a seat later for the runner basin *L* Fig. 2.

The spigot extension pattern is drawn first, then the body pattern. Clamps holding the flask to the ramming stool are removed and small clamps, inserted in the gaps *N* Fig. 3, are employed to attach the lifting, or, stripping plate to the lower flange of the bell flask section. The entire flask then is lifted about 12 inches at which point the stripping plate is released and allowed to drop back on the stool. After the mold has been finished and blacked it is clamped on a casting stool on which a core

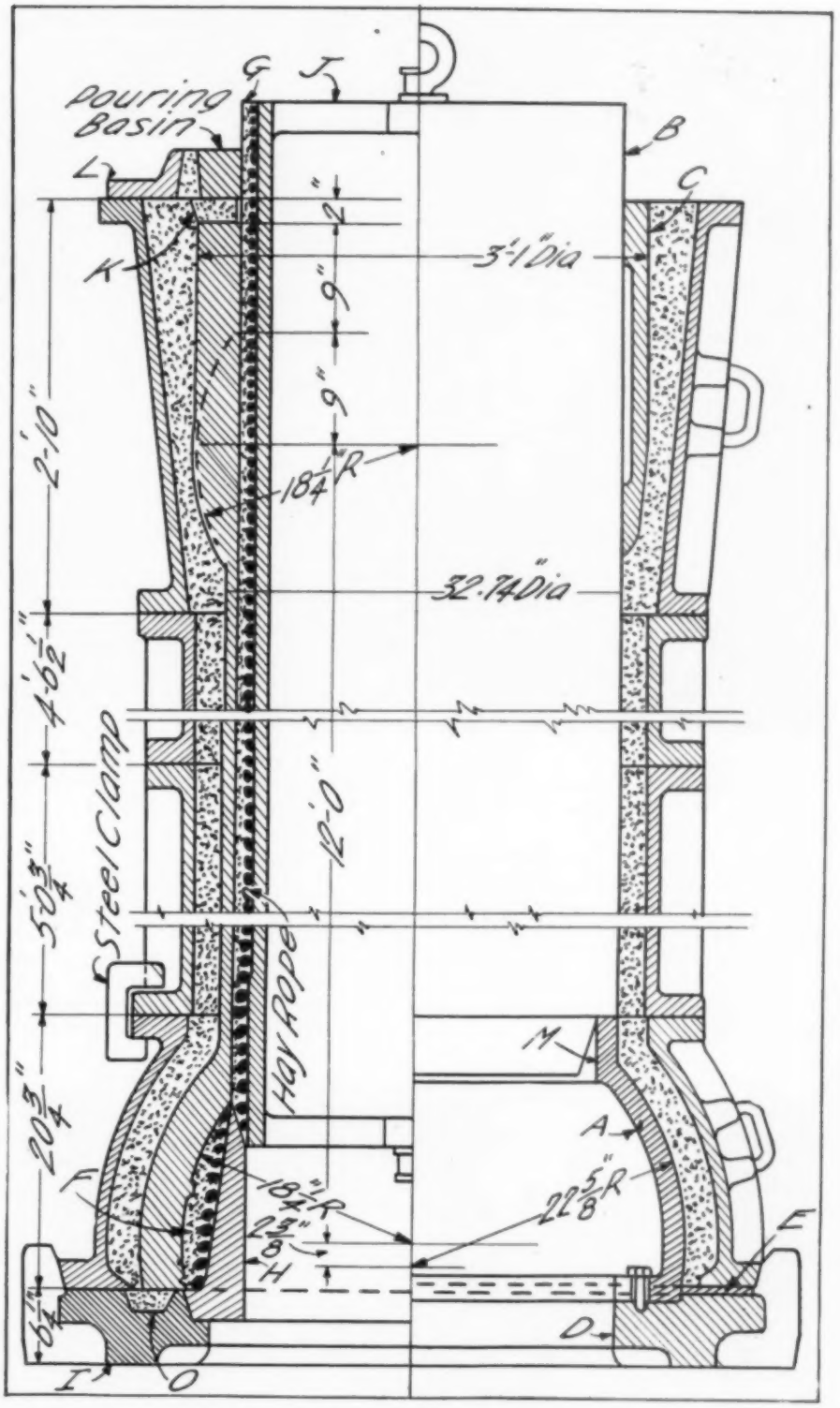


FIG. 2—LEFT—ASSEMBLED MOLD AS IT WOULD APPEAR AFTER THE CASTING HAS BEEN POURED RIGHT—DETAIL OF FLASK AND PATTERN

already has been rammed as shown in the right foreground Fig. 3. The mold is blacked by throwing several buckets of blacking against the face through the upper opening. The blacking runs down the face of the mold and what does not adhere, drains into a tub at the bottom. The mold then is set up in the pit over one of a number of fire places and allowed to dry over night. These fireplaces are built unusually strong because after the flask is set on to dry it is not moved again until after the casting has been poured.

The core for the pipe is made in two sections, a straight body part extending almost the full length, swept up in loam on a cast iron barrel and a head core made of dry sand rammed around a socket iron which fits into the casting stool and also supports the weight of the body core. A body core in course of construction is shown in Fig. 5. The cast iron core barrel provided with rows

FIG. 3—THE HEAD CORE IS MADE OF DRY SAND RAMMED AROUND A SOCKET IRON WRAPPED IN A SINGLE LAYER OF HAY ROPE—THE PATTERN FOR THE HEAD WITH STRIPPING PLATE AND RAMMING STOOL ATTACHED IS SHOWN TO THE LEFT AND THE HEAD CORE MADE UP IN THE DRYING AND CASTING STOOL IS SHOWN AT THE RIGHT

of ⅝-inch drilled holes on 6-inch centers is supported on steel spindles. The spindle shown in the illustration is at the end of the barrel which forms the lower core print. The spindle at the other end is provided with an eye hole and squared end through which the core barrel is driven by a small air motor in process of constructing the core. The details of the upper spindle may be observed in the illustration Fig. 4.

The first layer of loam, carrying a high percentage of clay, is daubed over a single thickness of hay rope wound tightly on the barrel from end to end with the exception of a few inches at one end where the core print is to fit *iron to iron* in the socket at the bottom of the mold. The core is loaded on a car equipped with suitable stands for carrying three cores and shoved into an oven where it remains about an hour. It is then taken out and given a second coating of loam mixed with sharp sand. The first coating of clayey loam cracks extensively in drying and in addition to affording egress to the gas generated during pouring, the cracks help to hold the second coating of loam. After the core is blacked it is dried in the oven for 3 or 4 hours and then is taken out and lowered vertically into one of the waiting molds. The core strike is reinforced with a metal strip and also with metal bearings at each end where it comes in contact with the turned ends of the barrel and is tested at intervals to see that it is perfectly straight and set to the proper radius.

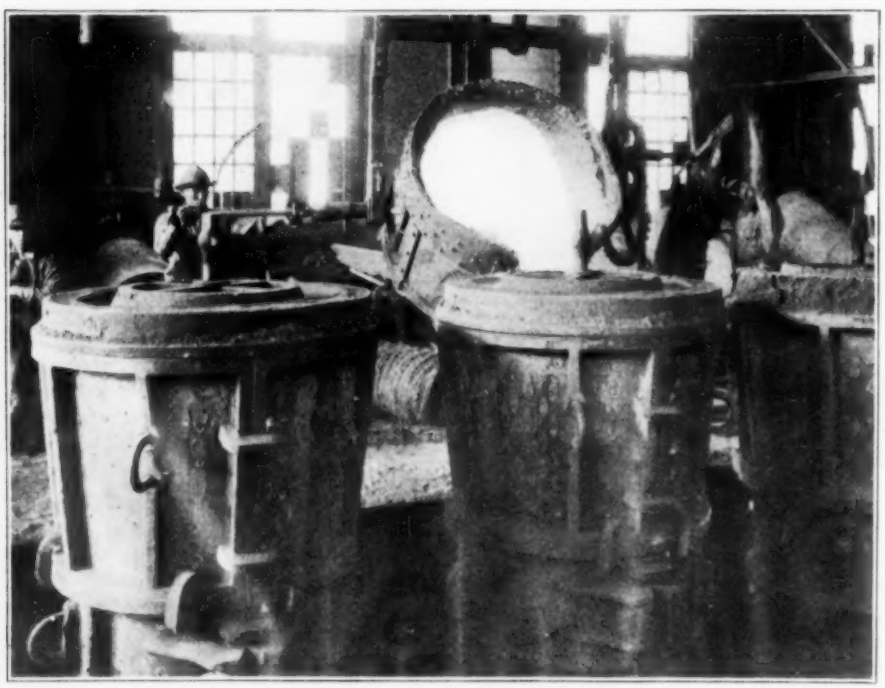


FIG. 4—MOLDS ARE ASSEMBLED AND POURED IN A PIT 12 FEET DEEP—THE MAIN CORE FORMS THE INSIDE OF THE RUNNER BASIN—THE OUTSIDE IS FORMED OF DRY SAND RAMMED IN A CAST IRON RING

The Head Core

The equipment and various steps employed in the preparation of a head core, are shown in Fig. 3. The socket iron is wrapped in a single thickness of ¾-inch hay rope and then lowered into a corebox where the space between the hay rope and the frame of the corebox is rammed full of core sand in the usual manner. The lower section of the corebox is made in halves so that it may be removed laterally after forming the ring for the lead stop and the double lead grooves. The upper section of the corebox is in one piece conforming in shape to the neck of the bell and is lifted off first after the core is rammed. After

FIG. 5—THE LOAM CORES ARE SWEPT UP ON LONG CAST IRON BARRELS DRIVEN BY A SMALL AIR MOTOR

both parts of the corebox have been removed the socket iron with core attached is picked up by three steel handles on the interior and set into one of the casting stools as shown in the right foreground Fig. 3. It will be noted in Fig. 2 that the casting stool is provided with a groove at *O*. This is filled with sand to prevent the end of the bell from coming into contact with the iron face of the stool and thereby becoming chilled. After this groove has been filled with sand and slicked as shown at *O*, Fig. 3, the core is blacked and then the stool is set over the fire for drying. The flask containing the mold is lowered into place on the casting stool and mold and head core dried at the one time. The ramming stool and casting stool are provided with four accurately machined lugs for guiding the flask into place.

The ring core shown at *K* Fig. 2, serves as a covering and runner core. The outside circumference is slightly tapered and fits into a similar taper on the upper circumference of the mold. The inner circumference fits closely against the body core and holds it central in the mold while the mold is filling with iron. A number of small rectangular slots on the inner circumference of the ring core serve as gates through which the iron enters the mold. A cast iron

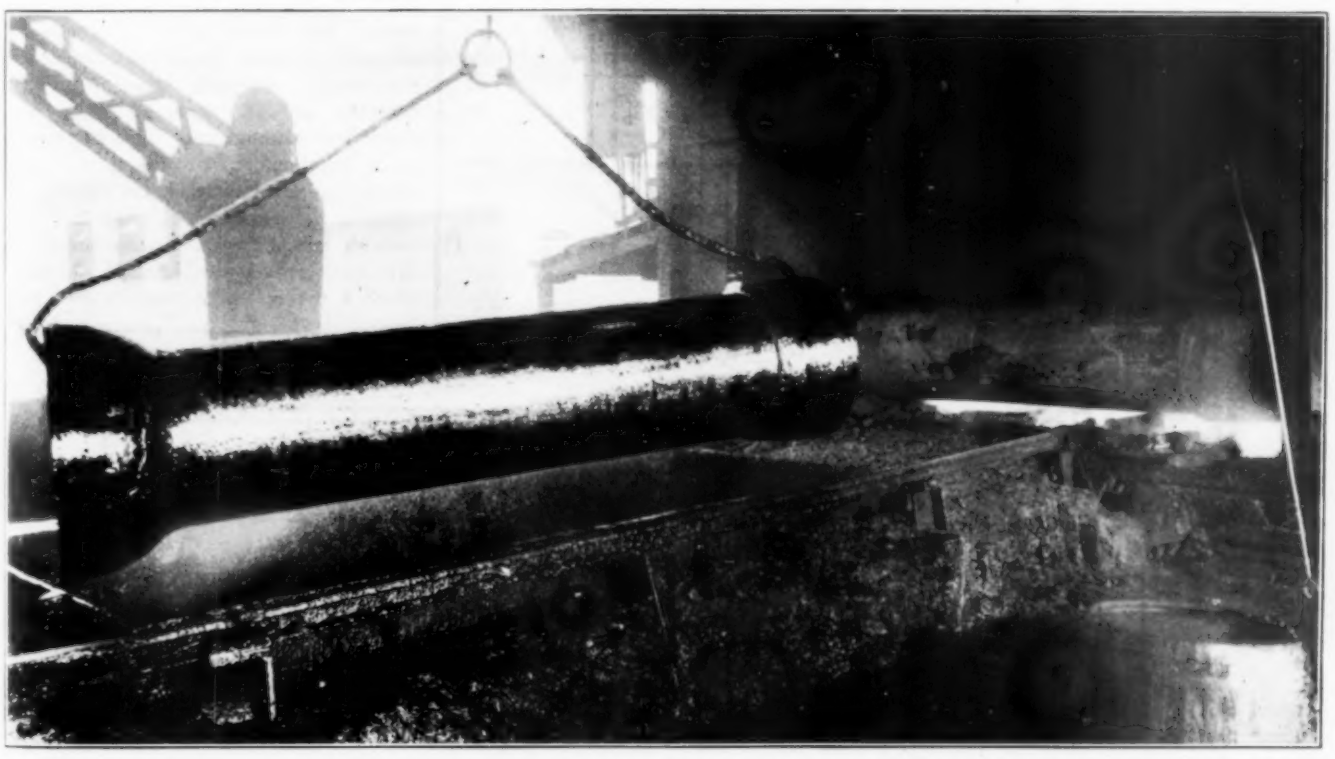


FIG. 6—THE PIPES ARE HEATED TO 300 DEGREES FAHR. AND THEN DIPPED INTO A TAR BATH

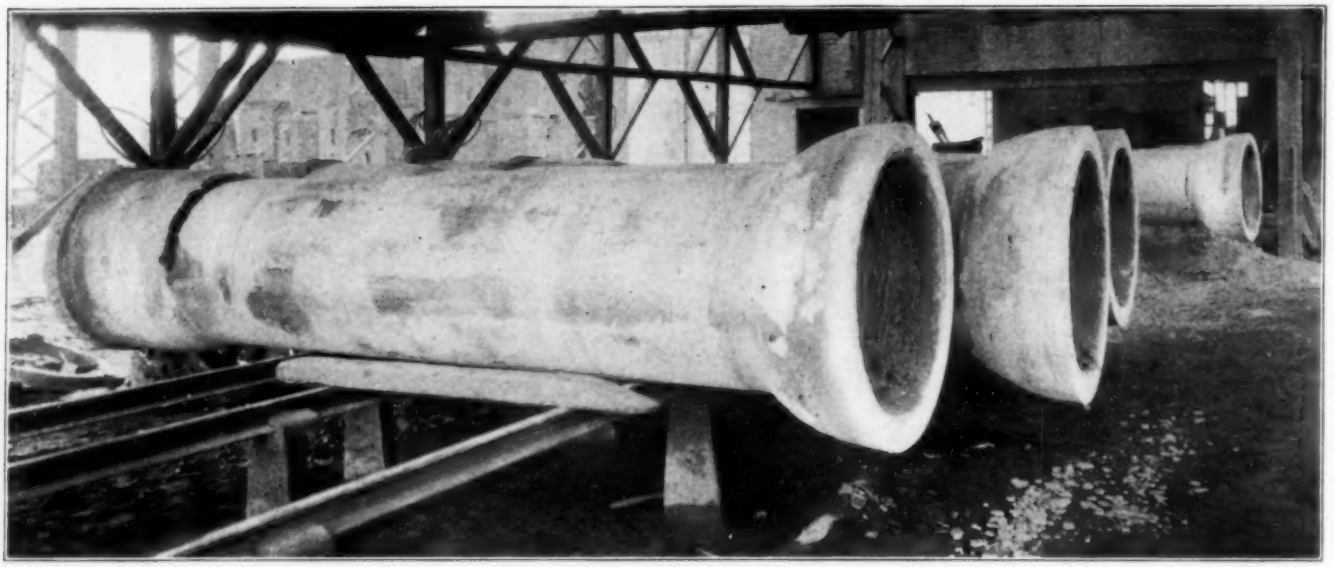
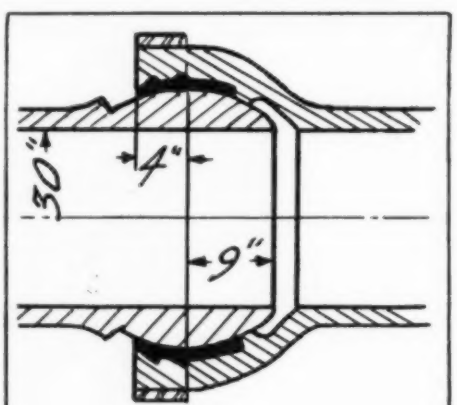


FIG. 7—THE CASTINGS ARE CLEANED AND CHIPPED ON A SKIDWAY LEADING FROM THE FOUNDRY TO THE MACHINE SHOP—THE SAND SHELL ON THE INTERIOR IS LOOSENED BY LONG POINTED BARS AND THEN SCRAPED OUT

flanged ring lined with loam, *L* Fig. 2, is set on top of the assembled mold and serves as a runner basin. The lining in the basin projects in over the ring covering core and prevents it from lifting when the mold is filled.

Pouring the Casting

Several features connected with pouring the castings are shown in Fig. 4. The mold on the right has been poured and the ring of iron remaining in the runner basin has been removed. Judging by the position of the ladle, the mold in the center is about half filled. The mold on the left is ready to be poured. The finished casting weighs 7400 pounds and therefore, it is necessary to use a 5-ton ladle to provide extra metal for shrink head, runner, and machining. For instance, 400 pounds of metal is cut off the spigot end of each pipe. About 1 hour after the casting is poured the core barrel is extracted by a special device which hooks into the upper end of the core barrel, and 4 or 5 hours afterward the flask is lifted out of the pit and the casting stripped. One of the flasks is shown in Fig. 1, just as it was lifted out of the pit. Note the relative size and the manner in which it is handled by the crane. The half flasks forming the spigot end of the mold are removed first, then the clamps are knocked off the flanges that hold the bell sections in place. The straight sections containing the casting are tipped over horizontally and placed on skids where the clamps are knocked off, the flask opened and the casting rolled out. The sand falls through a grating into an under ground chamber where it is retempered and returned to the molding floor. The flasks also are reassembled and returned to the ramming station and the castings are rolled along the skids and cleaned as shown in Fig. 7. The shell of loam remaining in the casting is removed with long pointed steel bars. By referring to Figs. 2, 6 and 8, it will be noted that the spigot end instead of being spherical as in the finished casting, is made with straight sides and in addition is carried up 9 inches, the extra metal acting as a sink head and dirt catcher.



Coated and Tested

The manner in which the pipe is coated is indicated in Fig. 6. Before it is dipped it is heated in an oven provided with an open fire under a pair of long skids. The pipe is rolled in at one end, allowed to travel through slowly and by the time it has been raised to a temperature of 300 degrees Fahr., it is rolled out through the opposite end on to a continuation of the skids which extend over a long tank or dipping vat. Here it is immersed in coal tar pitch varnish at the same temperature and afterward rolled away on the skids and allowed to cool off gradually to atmos-

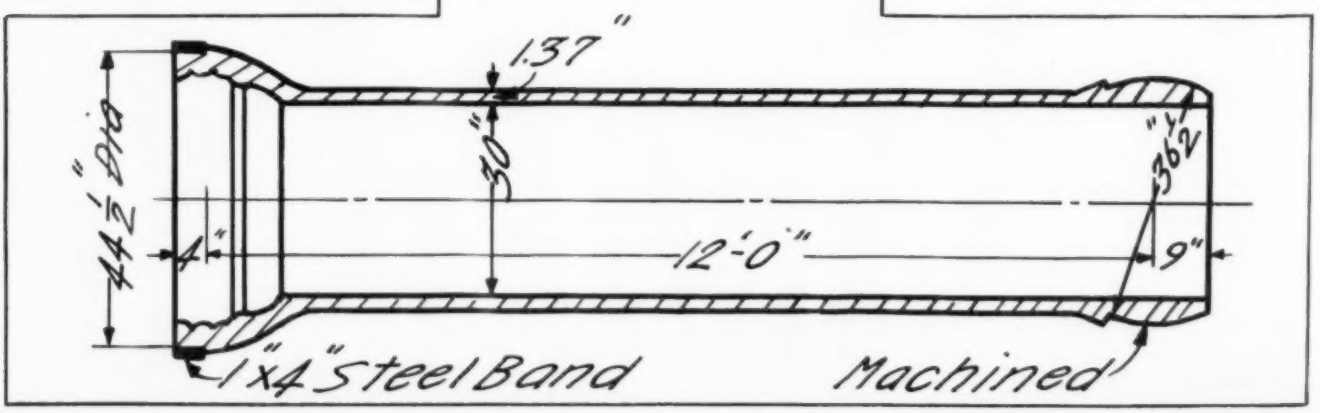


FIG. 8—SHOWING DETAIL OF FINISHED PIPE JOINT, ALSO THE STEEL BAND SHRUNK AROUND THE BELL END FOR REINFORCEMENT DURING HANDLING AND TRANSPORTATION

pheric temperature. In the illustration one pipe is shown emerging from the bath and a second pipe is shown emerging from the oven. After the pipe has cooled and the coating become hard, a pressure test is applied. According to the specifications of the American Water Works association, pipes in this class must withstand a hydrostatic pressure test of 300 pounds per square inch. The test press shown in Fig. 9, consists mainly of two substantial cast iron stationary supports connected by two heavy steel bars. A moveable head suspended from the upper steel bar and connected to the plunger is forced against the spigot end of the pipe which in turn forces the bell end against the opposite support. A heavy manila rope packing ring is inserted between the support and the pipe at each end to prevent leakage. The pipe then is filled with water through holes in the heads and pressure applied. After the necessary pressure of 300 pounds to the square inch has been established and before it is released, the pipe is subjected to a hammer test to insure that it is free from concealed defects such as blow holes, cold shuts, dirt or dross. Castings that withstand the rigid inspection successfully, are transferred to the machine shop where the sink head is cut off the spigot end and the end of the pipe afterward machined to the required spherical shape. The interior of the bell end is machined to a similar shape and the outside is machined on the end to receive a shrunk-on steel band 1 x 4 inches.

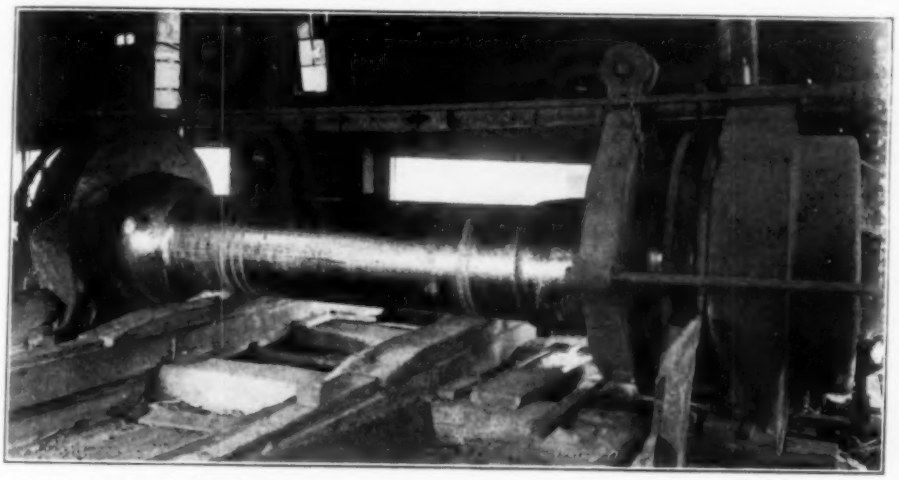


FIG. 9—WHILE UNDER A HYDROSTATIC PRESSURE OF 300 POUNDS TO THE SQUARE INCH THE CASTING IS HAMMER TESTED ALL OVER IN A SEARCH FOR HIDDEN DEFECTS

Acquires Australian Firm

In 1915 the Australian Electric Steel, Ltd. was established at Alexandria, (Sydney) Australia, under the management of J. M. Deschamps. A plant was built to manufacture high-grade steel by the electric furnace process. Previous to this time Australia had always been dependent on foreign countries for their steel products. However, Australia today produces large quantities of various grades of steel hitherto imported. In 1920 J. M. Deschamps visited England and there arranged the association of his company with the firm of Hadfield's, Ltd. of Sheffield. When he returned to Australia in 1921 a new company—Hadfield's (Australia) Ltd.— was registered with a capital of £500,000. This new firm absorbed the Australian Electric Steel Ltd., Mr. Deschamps retaining the managing directorship and Sir Robert Hadfield, England's foremost steel scientist taking a place on the board of the new company.

At present, over 12,000 tons of electrically refined steel have been produced by this plant, and material supplied to over 600 large government and industrial enterprises. More than 250 different varieties and grades of steel have been produced including a range of carbon steels and a large variety of alloy steels such as manganese, chrome, vanadium, chrome-vanadium, chrome-nickel, nickel and many other varieties of tool steels.

Hadfield's (Australia) Ltd. has well equipped laboratories fitted with all the most modern appliances and manned by thoroughly competent steel metallurgists and chemists who not only work on the production of steel but also with the raw materials used.

Since the establishment of the plant in 1915 it has expanded until its capacity is four times what it was originally. At present because of the enormous market for its products the company has started to build greater additions with the plan of doubling their present size. In addition to these buildings which are at Alexandria, Sydney, another large structure is projected at West Guildford, W. A.

Book Review

Electro Deposition of Copper, by Claude W. Denny; 108 pages, 4 x 6½ inches; paper; a volume of Pitman's Technical primer series, published by Sir Isaac Pitman & Sons, Parker St., Kingsway, London, W.C. 2, and for sale by THE FOUNDRY; price, $0.85 net.

The purpose of this volume is to explain the art of electro-deposition, especially of copper, and to describe some of its many applications. The first half of the book is devoted to an explanation of the subject in general, dealing with testing solutions, preparation of work for electro-deposition, non-adhesive deposits and their removal, etc. The latter half takes up a few of the various applications such as electro-deposited radiators, electro-deposition in producing gramaphone records, electro-coppering armor piercing bullets, copper plated airplane propellers, etc. The subject is such a broad one that the author has only mentioned the more important methods and applications. However, these have been taken up in detail and are explained fully. This volume is valuable as a hand book for the electro plater or electrical engineer, and should prove of particular value to the man who hasn't the time for a more elaborate treatise.

Hold Meeting at Montreal

The American Electrochemical Society has made arrangements to have its fall meeting at Montreal the 21, 22 and 23 of Sept. Headquarters will be the Hotel Windsor. The technical program includes from 16 to 20 papers. Arrangements have been made for a smoker, and an inspection trip through the industrial plants at Shawinigan Fall.

Melt and Anneal Electrically

(Concluded from page 612)

provided for warming up, due to the heat transfer just described, then two hours of heating in the central heating zone, and finally another four hours cooling.

The temperature in the heating zone in each tunnel is regulated by a control, produced by Leeds & Northrup Co., Philadephia, and is protected by hot fuses which prevent the temperature rising above above 1900 degrees Fahr.

The section of the Yale & Towne foundry given over to electric casting and annealing furnishes an excellent example of what may be accomplished in the use of electricity in a foundry. Here all equipment is operated electrically. The foundry uses the step down transformers and is metered at 2300 volts.

Making Malleable Castings--II

Metallurgical Problems Encountered in Melting Are Discussed and Suggestions Offered—Equipment and Reactions Which Take Place in Annealing Are Described—Finishing Castings

BY ENRIQUE TOUCEDA

ALL of the author's correspondents and visitors appeared to be familiar with the reactions that take place in the air furnace. Covering the ground briefly, it can be stated that the carbon is eliminated, mainly as CO. Neither the sulphur, nor the phosphorus, are permanently oxidized, while there is an increase in the former that may amount to little or much, depending upon the amount of sulphur in the fuel. The silicon and manganese are in part oxidized to silica and manganous oxide respectively, while, unavoidably, some of the iron is being oxidized at the same time, with the result that double silicate of iron and manganese is formed, which if the lining and bottom were inert and no dirt or sand accompanied the charge would constitute the slag. As there is more or less erosion of both sidewalls and bottom, and invariably some foreign siliceous matter is introduced with the charge, the slag consists of mixed silicates of iron, manganese, alumina, lime, magnesia, soda, potash, etc., in which the silicates of iron predominate.

In a normal heat the elimination of that part of the silicon, manganese and carbon which is lost, takes place mostly while the charge is melting, and in the absence of small or thin scrap, will amount to about 28 per cent of the silicon, from 15 to 19 per cent of the carbon, and from 40 to 50 per cent of the manganese, all based upon their original content in the mixture. If it is expedient to use small thin scrap, owing to its lower cost or because it is a by-product of the plant, it should be charged in the molten bath in order that it will be protected from excessive oxidation.

While the composition, to which reference has been made, is the one recommended for general use, it is not to be understood that quite wide departure cannot be taken in the case of most of the elements. Some 10 years ago attention was rarely, if ever, paid to the carbon content in the product, principally because its importance was not recognized. Inasmuch as the carbon content in pig iron must have averaged at least as high as 3.35 per cent, and as the sprue must under these conditions have been exceedingly high in this element, it was imperative to run on a low-silicon mixture in order to secure a silicon-carbon ratio that would yield white iron in sections of even medium thicknesses. While today it is in no sense unusual to run both thin and heavy castings from the same furnace, at the time referred to, this was not considered practical. As a general proposition little thought was given to manganese, which was frequently too low or too high, with the result that many heats of low silicon, accompanied by low manganese, resulted in the production of a picture-frame product, by which is meant a finished product that shows upon fracture an outer surface ring or frame ranging in thickness from 1/64 to 1/16 inch, or even deeper in exaggerated cases; wholly different in appearance from the metal which it surrounds and separated from it by a sharp line of demarcation. As a matter of fact, this character of fracture, whether resulting from this or other frame-producing mixtures, was so general that the name black-heart malleable iron was given to the finished product, and there is ample evidence to show that it was the aim to obtain this character of fracture.

The author's reason for placing the silicon at 0.90 per cent and the carbon at 2.35 per cent is because these figures call for a silicon content of about 1.25 per cent and a carbon content of about 2.70 per cent in the mixture—limits sufficiently high, on the one hand, to produce a product whose mechanical properties still will be excellent, even if the oxidation of these two elements exceeds their average elimination by a substantial margin; while on the other hand, in the event that the elimination is somewhat less than the average, neither are so high that the product will suffer deterioration in consequence.

The fact must not be lost sight of that the percentage of silicon, carbon, and manganese recommended for the mixture is at a point at which, if the furnace is worked normally, the metal will be hot enough to pour by the time the molten bath has arrived at the hard-iron composition decided upon. As has already been indicated, not only is the best design of air furnace a rather crude affair, but it is not operated by metallurgists—a 20-ton air furnace designed by the author, that seems to have given satisfaction, is outlined in Fig. 3. Consequently, for commercial reasons, it is well to aim for that composition which safely will admit successfully of reasonably wide variation. With a sulphur content of 0.06 per cent, and other elements balanced, it makes but little, if any, difference in either the tensile or shock test, whether the manganese is as low as 0.22 per cent or as high as 0.30 per cent. While further reference to manganese will be made, the author would point out that, as far as he is aware, there are still some things to learn about this element and the manner in which it is capable of existing in malleable iron. It is a generally accepted fact that, if the manganese is in excess of the amount necessary to unite in theoretical proportion with sulphur to form manganese sulphide, the excess will unite with carbon, and a manganiferous cementite will be formed instead of the single carbide of iron. However, when graphitization takes place and is completed, in what form does this excess manganese remain in the finished product?

Phosphorus in Malleable Iron

Concerning phosphorus, the limit has been placed at 0.20 per cent, because, when in this amount, it does not appear to produce an abnormal appearance of fracture, even in the case of thick sections, at annealing temperatures around 900 degrees Cent., nor does it appear to lessen strength or ductility. It happens, however, that the limits for the impurities are so interdependent that, for economic reasons, prudence calls for what might be termed a metallurgical safety factor in the balancing of the different elements. For thin sections like stove plate it is well to work on a phosphorus content of about 0.26 per cent, due to the increased fluidity resulting therefrom, coupled with the fact that the fracture is in no way undesirable.

Some hints may prove of value in connection with the operation of the furnace. The author has already pointed out that the coal bed should be left

undisturbed except to level the bed. He would make the same recommendation in connection with the molten bath of metal, except the necessary disturbance that takes place in hooking into the bath partly exposed pig or sprue, to expedite fusion during the melting down period; while removal of the slag should be postponed as late as is practical. If machine-cast pig can be purchased as cheaply as the sand-cast, this should be used in preference; while it will be found, if the sprue is partially broken up by means of a light-weight sledge, that, owing to its brittleness, not only can this be done quickly and cheaply, but through this practice much of the adhering sand will be knocked off that otherwise would find its way into the hearth, with the further advantage that the sprue can be charged much more compactly. Every effort should be exercised to prevent foreign siliceous material from entering the hearth, when this can be accomplished at little cost. In a test on 12 heats, amounting to a total of 192.8 tons, the slag from these heats amounted to a total of 12.7 tons, or 6.62 per cent. From this slag there was recovered 5140 pounds of metallic iron. At this plant no special precautions had been taken to prevent foreign siliceous matter entering the hearth. It will be found, if such precautions are taken, that a substantial benefit can be affected by the end of the year through a saving in fuel, in better furnace control, less slag to wash, etc. If, due to lack of business, it is essential to run the air furnace at considerably less than capacity, the hearth should be shortened by filling-in with bottom sand at the rear bridge, for such a distance as will leave the bath, when molten, almost as deep as when the furnace is being run at capacity; otherwise, due to a shallow bath, the elements will be oxidized to a greater extent than under normal operations.

In determining the space between rear bridge and roof, to regulate flame travel, it is advisable at the start to build the top of the bridge slightly too low, securing the final adjustment by bricking-in at each end between bridge and roof, through which procedure the correct area, more quickly and conveniently, can be ascertained, after a trial or two, than through adding or removing a course of brick from the top of the bridge.

In following the progress of the heat it is the general practice to cast what are called test sprues at intervals of about half an hour after the charge has melted. These are broken and the fracture examined, in order to ascertain the rate at which graphitization is diminishing. In the cooling of these test sprues the practice varies, and it is possible that the fracture, far from enabling one to approximate closely the correct story, can be misleading. Two precautions must be taken. First, the center section at about where the sprue should be broken should not be less than about 1⅞ inch in diameter and the cooling should not occupy less than about 20 minutes. As soon as the sprue has solidified it should be removed from the sand, which should be scraped from the surface. It should be cooled in the air for 10 minutes, and then quickly plunged in water and almost instantly removed, this procedure being repeated about every half-minute, allowing the sprue to remain in the water for a slightly longer interval at each dip, and this continued until when again dipped it ceases to create any visible agitation. At this temperature, if broken, it will have the same appearance as if it had not been fractured until actually at atmospheric temperature. If, instead of one sprue, two are poured at the same time, one being allowed to cool normally in the mold, in order that its fracture can be subsequently compared with the sprue that was cooled in the regular manner for test purposes, it will not be long before an observer can closely estimate and allow for the effect produced by the drastic cooling. If the cooling of the test sprue is carried out in this manner it can be stated that for castings with sections as thick at ⅞ inch no danger need be anticipated, that primary graphite will not be present if in the sprue last taken the fracture shows clear, except for the presence of a few minute specks of graphite sparsely disseminated throughout.

At this point a few words in connection with the castings as cast may prove pertinent. If owing to the use of a poor consignment of fuel, to neglect, or to bad judgment on the part of furnacemen, a heat is delayed and an undue amount of silicon, manganese, and carbon eliminated, this can be detected by the sudden stickiness and sluggishness shown by the metal as it is being poured from the test ladle, also by the appearance of pin holes at different places on the periphery of the thin rim of the test sprue. While castings from such a heat would, when annealed, have a picture-frame or an all-steely fracture, dependent upon how badly the metal is oxidized, the heat can be saved if promptly treated by a silico-spiegel addition, or an addition consisting of a combination of ferrosilicon, ferromanganese, retort coke, and iron borings bonded in briquet form, the borings being added to give increased weight to the mass in order that it will sink into the molten bath as far as possible. It can be stated that, through close observation, almost any over-oxidized heat may be saved in this manner.

Wrong Cause Blamed

But whether the castings are derived from a heat of the composition recommended, from a heat from which a greater amount of the oxidized elements have been eliminated than in the case of the former, or from one in which the carbon particularly borders on the higher limit, there are certain practices concerning which the author would hesitate to make mention were it not for the serious losses sometimes occasioned through neglect to observe precautions of so obvious and commonplace a nature. At times complaints have been received concerning the heavy losses resulting from the checking and cracking of castings. With the knowledge possessed by the foundrymen that the lower the carbon the less fluid, and the higher the contraction of the molten air-furnace iron, he is prone to attribute such losses when extraordinarily heavy, wholly to the fact that in the effort to obtain strong and ductile metal, the fluidity and contraction of the iron have been adversely affected through the use of a low carbon metal.

In his examination of some of these complaints, the author has found con-

Table I

Malleable Irons Treated in Muffle Furnace

ANALYSIS OF HARD IRON

Mark	Silicon	Phosphorus	Sulphur	Manganese	Comb. Carbon
1	0.76	0.193	0.050	0.200	2.13
2	0.88	0.180	0.051	0.230	2.26
3	0.80	0.190	0.049	0.200	2.37

PHYSICAL TEST

Mark	Tensile strength, pounds per square inch	Elongation, per cent in 2 inches	Reduction of area, per cent
1	59,360	36.7	38.0
2	58,464	35.9	33.2
3	57,792	25.7	30.1

ditions, entirely apart from composition, that have actually invited this character of trouble. Owing, mostly to failure on the part of the designing engineer to co-operate with the foundry engineers, the foundry is called upon to make castings from patterns of intricate design and of unreasonably disproportionate sections and not infrequently from poor pattern equipment.

Severe Cooling Strains

Hard-iron castings of this description must be in a state of severe strain even when allowed to cool in the mold, and much more so, when cooled as evenly as is commercially practical, while the design may be so unnecessarily faulty that even under test conditions of commercial practice the loss from cracks and checks may prove prohibitive in certain cases. If the foregoing is true, what can be expected in the many cases that have been seen in which the castings have been stripped a few moments after solidification, with half of the castings buried in the still hot sand and the other half exposed to the draughts of the foundry atmosphere. Not infrequently there will be seen a laborer wetting down the sand on a floor adjacent to the one where the castings have just been stripped, and as he playfully looks around, the nozzle of the hose will partially swing around and drops of water will be sprayed over the red-hot castings, with the development perhaps of a check where each drop fell.

Obviously, as the carbon is gradually lowered, both fluidity and contraction are adversely affected, but the author believes that there will be found to be little difference in these properties as between a carbon content of 2.50 per cent and 2.35 per cent, but a more consequential and serious difference between a content of 2.35 per cent and 2.00 per cent. While no manufacturer aims to run as low as 2.00 per cent carbon, this figure accidentally may be reached when aiming to run on a content of 2.35 per cent. The point the author would bring out is that from complaints investigated, he is forced to conclude that carelessness has contributed more to heavy crack and check loss than has a low carbon content.

In the foregoing remarks on the air furnace, no efforts have been made to cover anything aside from the *high spots*. With few exceptions, this is the furnace used in the States, owing to its cheapness and its simplicity of construction and repair. The open-hearth is much more costly to build, with the net result that no fuel economy results from its use owing to the fact, not that it is not a more efficient melting apparatus, but that it must be kept hot when not in operation in order to prevent the spalling of the silica brick. The author does not believe that the use of the electric furnace is warranted, except perhaps in unusually large installations. There is no advantage to be gained in running on an extremely low-sulphur-phosphorus content, but on the contrary many disadvantages.

To prepare the hard-iron castings for heat treatment they are freed from adhering sand and then trimmed. They are then placed in receptacles called pots or rings of the shape of a band in that they have neither top nor bottom. A ring is placed on a stool of solid iron about 3 inches thick and somewhat larger in perimeter, on the bottom of which are lugs about 5 inches high that serve as feet, and which are so spaced as to admit of the lifting fork of the charging truck being introduced beneath the stool. This ring is then filled with castings which are surrounded with a packing, the nature of which will be entered into later.

Packed By Charging Trucks

Another ring is placed upon the first one, and the process continued until four or five rings have been used, the entire assemblage being called a stand. These stands are then picked up by the charging truck, operated by electricity, air, steam or by hand, and taken to the heat-treating oven, where they should be placed in straight rows, the row nearest the side wall being spaced at least 5 inches from it, and a space of 4 inches left between the other rows. No mistake could be greater than to jam the stands close together, as it is of prime importance that heat circulation be given its greatest opportunity. The castings are surrounded with a packing to prevent kiln warp, and for the purpose also of furnishing an oxidizing pot atmosphere that will facilitate the decarbonization of the metal. The latter object has been given an exaggerated importance as far as present day practice is concerned.

In the old days, with castings having a carbon content of 3 per cent or over, this may not have been the case, but with the carbon content now present a strong packing is a mistake rather than otherwise. Even a packing of sand, if properly sized, will hold enough air to admit of all the oxidation necessary to produce a superior product. The really important matter is to have a packing, preferably containing about 10 per cent of iron oxides, the balance being of an inert character of the nature of slag, or other material that will have little tendency to combine with the oxides of iron at the temperature of anneal. The latter condition is important in order that there will be no tendency for the packing to lump, and in order that the casting readily can be shaken out clean and free from adhering packing. As a matter of fact, in muffle ovens of the tightest construction, in which castings are packed solidly, so that the only unoccupied space in the muffle results from the voids occasioned by the castings, the decarbonization is as complete as in the case of the strongest packing now used, as may be seen from Table I, which has reference to three test bars selected on the author's last visit to a plant where no other type of oven is used.

If castings are being made that are not liable to warp, the muffle oven is the type to build. A good construction of muffle is by the use of the Manion type of brick. This brick is thin, but reinforced by webs that serve for the most part to carry the load, with the result that the heat can be transmitted to the inside of the muffle quickly and economically.

If the muffle is made of carborundum brick a strong and lasting muffle will result, through which the heat readily can be transmitted from the flame. A number of foundrymen who have consulted the author have been scepitical in regard to the character of product that can be derived from the muffle oven. In order to quiet any who may feel likewise it can be stated that in the American Malleable Castings association, of which the author is consulting engineer, one of the member firms makes use of the muffle-type oven only, and its record for quality is amongst the highest. The results quoted in Table I illustrate what can be accomplished in the muffle oven. The product made by this particular concern will average about 53,980 pounds per square inch in tensile strength and run somewhat over 20 per cent in elongation.

Heat Treatment Limited

As stated, to obtain a product high in tensile strength and ductility, the composition of the hard-iron castings must be restricted to within certain limits. Assuming that castings are being heat treated that correspond to these composition requirements, it can be stated that the castings preferably should be held at a temperature about 100 degrees Fahr. (37 degrees Cent.) above the critical range for a period of not much less than 60 hours,

and cooled at a rate of 10 degrees Fahr. (5 degrees Cent.) or less per hour, until their temperature has fallen to about 100 degrees Fahr. under the critical range, after which the cooling gradually can be accelerated. However, it is one thing to possess an accurate knowledge of exactly what should be done in order that the best heat treating results will follow, and another to construct commercial apparatus in which a large quantity of material can be heat treated in conformity with the rules that are prescribed.

Some few years ago not only were most of the foundrymen lacking in a metallurgical knowledge of the process, but the apparatus was of such a faulty character that it was impossible to carry out in an effective manner what research had shown was essential if the superior product was to be obtained. In short, it often is much easier to indicate than to achieve, and while general instructions can be sent out as to the proper temperature at which to convert, the length of time to hold at temperature, and the rate at which the cooling should take place, this will prove of little avail if the heat-treating ovens are so constructed that proper thermal conditions exist in only a restricted area of the oven, and that the oven as constructed cannot be cooled at the rate designated.

Ovens Must Be Self-Contained

A brief attempt will be made to cover certain facts that must be considered in annealing-oven design. First of all, each oven should be self-contained in all particulars. The general method, almost universal some few years ago and in no sense uncommon today, of building a battery of 8 or 10 ovens with common side walls and a common stack is a serious mistake from many points of view. One can well imagine the unbalanced thermal conditions that must obtain when, as frequently happens, two contiguous ovens are under fire but the one at their other side cold. In such cases the common side wall of the two under fire is not exposed to the atmosphere, and consequently is radiating off no heat to it, while the other side wall is doing so at a rapid rate. It briefly may be stated that from the standpoint of cost, maintenance, and control, this system could not be worse. Rigidity of construction is one essential that is fatal to overlook. If the ovens are not rigidly built cracks will develop and it will be difficult, and perhaps impossible, to cool the oven from temperature at the rate desired. The walls should be at least 22½ inches thick, encased on the outside with steel or iron plate,

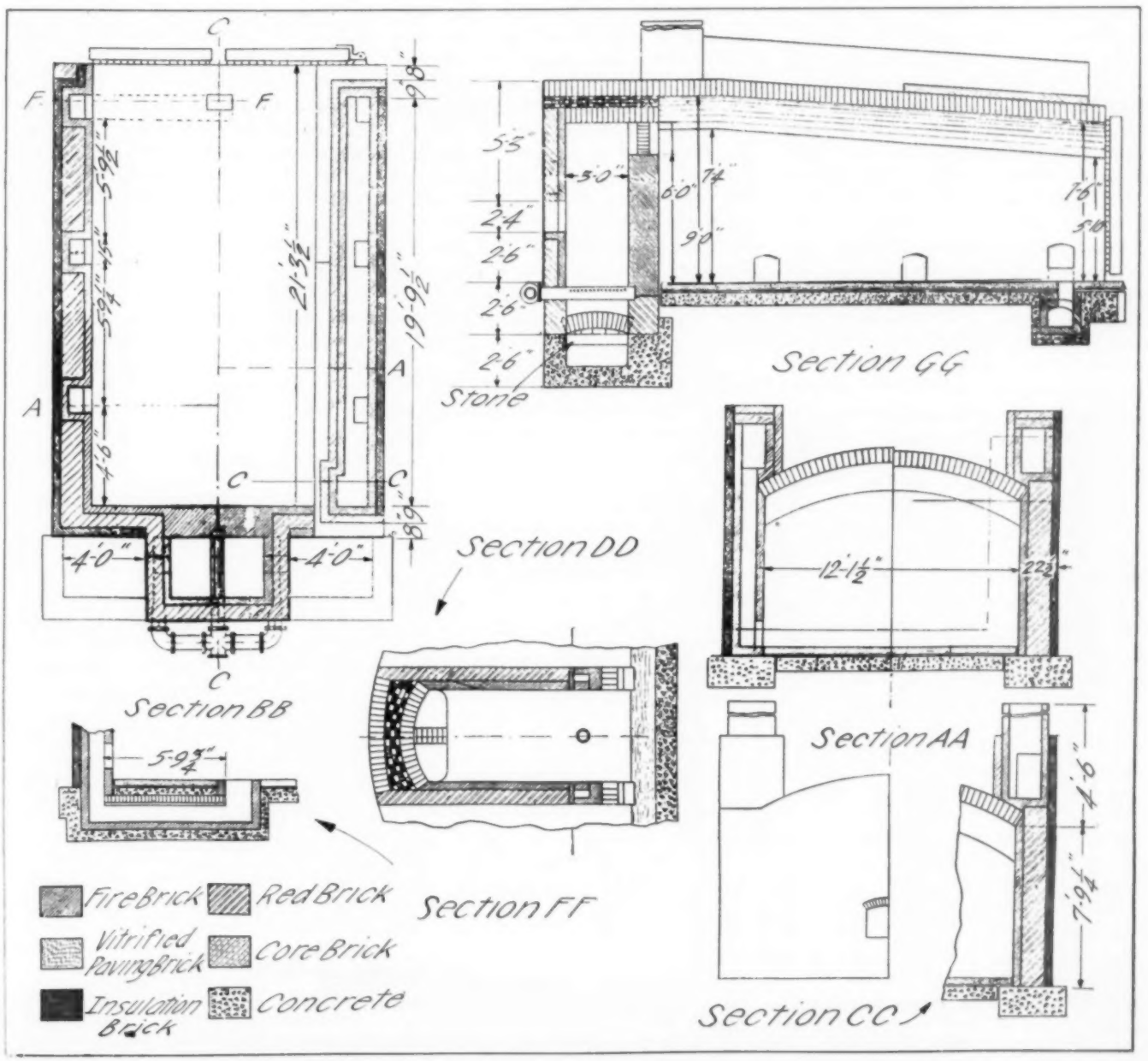


FIG. 4—DETAILS OF CONSTRUCTION OF ONE TYPE OF ANNEALING OVEN

and the whole reinforced by a system of buckstays set about 30 inches between centers where this is possible.

The walls and doors should be so thoroughly insulated that when the oven is at temperature the hand can be pressed against the plates without undue discomfort. The floor as well should be insulated and, for reasons to which we will refer later, so should the front half of the roof. The fire pot of an oven should be on its outside and not within it, as the oven proper is designed to heat treat castings and not for the purpose of burning coal. With the fire pot on the inside and, as frequently is the case, located at one corner only, it is not an easy task, if at all possible, to obtain heat uniformity within the oven, which statement holds true even in the event that a fire pot is placed within the oven at diametrically opposite corners. The floor should be built solid, with no underground flue system beneath it. The latter construction is of no benfit as far as a saving of fuel is concerned, and with a complicated underfloor flue system—now being generally discarded as new ovens are being built —the cost of this part of the oven equalled if not exceeded that of the rest, while owing to the jar produced by the loaded charging truck and the combined weight on a floor subjected to such a high temperature the maintenance cost is heavy. No underground flues are necessary aside from one small stack flue on each side of the oven, which preferably should be located on the outside, as close as practical to the side wall footings. In the last few ovens designed by the author he has placed one stack flue and one small stack on top of each side wall, the bottom side wall flue openings being connected with these stack flues by a vertical flue built within the side wall.

In this manner not only is all underground flue work avoided, but as the entire system is exposed the flues can easily be kept clean and tight. The ovens are built in rectangular form, width and length in the ratio of about 3 : 4. The fire pot is located on the outside, midway between the side walls, and is constructed on the gas-producer principle, that is, there is a water seal, air bungs through which about 400 cubic feet of air per minute against a 5-ounce pressure is admitted, a more or less deep bed of coal resting on ashes that reach from the floor of the seal to about 1 foot above the bungs. Between the actual roof of the fire pot and the fire is a false arch, and between it and the roof chequer work of brick through which hot secondary air for combustion of the combustible gases is drawn. These details are set out in Fig. 4. The opening from fire pot to oven, that is, the bridge, is located as high as possible in order that combustion will start to take place immediately in front of the chequer work and at the point where the roof of the oven proper slants toward the front. Through the use of a slanting roof the bridge can be located so high above the top of the stands, where the temperature is obviously the hottest, that no danger exists in over heating the castings in the topmost ring of the stand, while as the flame advances toward the front of the oven and its temperature drops by the amount imparted to the castings at any section, the roof is lower, and consequently a close heat balance is maintained until the front of the oven is reached. There are three side-wall flue openings at the floor line, leading into the vertical flues that go to the stack flue, with openings so proportioned that the heat of combustion is drawn to different parts of the oven in a uniform manner. The adjustment is made by means of a draft gage in such a manner that the draft in the two front flue openings is strongest but equal on each side, the next two less strong and equal on each side, and next still less strong and equal on each side. By means of this gage and a pyrometer the adjustments can be made after some three or four anneals have been run.

Controlled With Recording Pyrometer

The ovens are controlled through use of a recording pyrometer, the couple of which should be inserted in the center of a pot, located close to the side wall, as it is the temperature of the castings that is desired, and not that of the oven atmosphere. If this procedure is not adopted there is no certainty as to when the castings have arrived at temperature, and consequently the time at which the castings are held at temperature will be an approximation instead of a certainty. This design of oven is being installed quite generally as new ovens are needed, or the principles embodied in the design are adopted in so far as practical in the remodeling of old ovens.

For some years the author has endeavored to find some method in which temperature control could in some manner be made fool proof. The electric resistance oven seemed to be the only solution. Later an oven using a combination of any fuel, supplemented at certain times by electric heat was designed. In operation the oven and contents are to be heated in the ordinary manner by coal, and the firing continued during the period at which the castings are to be held at temperature, but so regulated that the temperature produced through this means and during this period should be some 150 degrees Fahr. (83 degrees Cent.) lower than required, the deficiency in temperature being supplied by electric current controlled by a potentiometer. It was thought that through this procedure not only could the temperature easily be maintained within a range of 10 degrees Fahr. (5 degrees Cent.) or less if need be, and lowered at the rate desired. Also through the proper proportioning and location of the resistance ribbon it was hoped the temperature could be maintained practically the same throughout the entire oven at the particular period when this is essential. In order to prove out the practicability of this scheme an oven was rigged up quite recently with the necessary number of grids of resistance ribbon and the other necessary details, in which two anneals have been run through. While a little trouble was experienced during the first anneal, owing to the parting of some of the hanger block on which the ribbon rested, this was corrected in the second trial. This scheme permits of the use of electricity in any oven, almost irrespective of its design.

Where oil and natural gas can be had cheaply these successfully can be used in properly designed ovens. However, in using these two fuels, the author believes that the oven should be designed in such a manner that the firing will take place at each end alternately at intervals of about 20 minutes. In this manner better control can be had than if the oven is fired at one end, or at both ends at the same time. If castings are being made that are not liable to kiln warp, the muffle oven is the type to build.

Concerning the matter of grinding, the practice at the present time is about fifty-fifty between grinding in the hard or grinding in the soft, with a tendency to the latter method and the use of the rubber-bonded wheel. Unless there is a good exhaust system in use with the grinding apparatus the odor imparted by the rubber wheel is quite objectionable, but otherwise not. Many plants grind the light castings in the hard with a vitrified wheel, but all heavy work in the soft. When the gates exceed a certain size the pneumatic tool is used to advantage.

There is little to be said about the molding sand except that the problem is one of increasing difficulty.

(Concluded on Page 631)

Chart Cupola Charging Data

Reliable Observation on Cupola Operation Supply the Foundryman with Information That Makes for Economy, and Form a Basis for Any Contemplated or Necessary Change in Methods

BY C. C. HERMANN

MANY foundrymen have, and all foundrymen should procure, reliable data regarding the operation of their cupola to determine what becomes of the material charged each day. Every foundryman knows that part of this iron burns out, literally goes up the cupola stack, part goes into the cupola drop and comes back in the next day's charge, some is dumped in the pig bed, a certain amount goes into shop equipment, some goes into the gates and sprue and the remainder goes into the castings. A part of what enters the castings is ground off in the cleaning department and another small amount is machined off in the machine shop. For intelligent operation the foundryman should know the relative percentages in each case.

He should know how much coke is necessary to melt the iron thrown into the cupola. A certain amount of coke is necessary on the bed and a certain amount under each succeeding charge of iron. The amount between the charges can be tapered within certain limits but he should know how much and what are these limits. The cupola must produce a given amount of iron at the spout per hour to pour the heat and data relative to the melting rate should be at hand. Fuel economy will depend on the intelligent operation of the cupola with respect to the amount of coke fired, method of charging the material, condition of the scrap, the use of flux, the blast and location of the tuyeres. These items all are within the control of the foundryman in case reliable records are maintained. To make a change without a proper basis or record of past performance is mere guess work and generally results in jumping back and forth with the ultimate result that every one becomes confused and every conceivable remedy is tried to find the solution.

A cupola report with the necessary data for a comprehensive study of performance consists of four parts; (1) record of charge; (2) record of coke charged; (3) record of production; (4) recapitulation of heat. The time required to collect this data is nominal when compared with the results attained and the trouble is slight since it falls right in with the ordinary procedure. Contrary to the supposition of many foundrymen little or no extra equipment is needed. Foundry reports in many cases have fallen into bad repute due to attempts to go too much into detail when such detail is not entirely warranted. It is advisable in this regard to make haste slowly, pick up a thread at a time here and there and co-ordinate the whole procedure toward the desired end.

A satisfactory form of cupola report

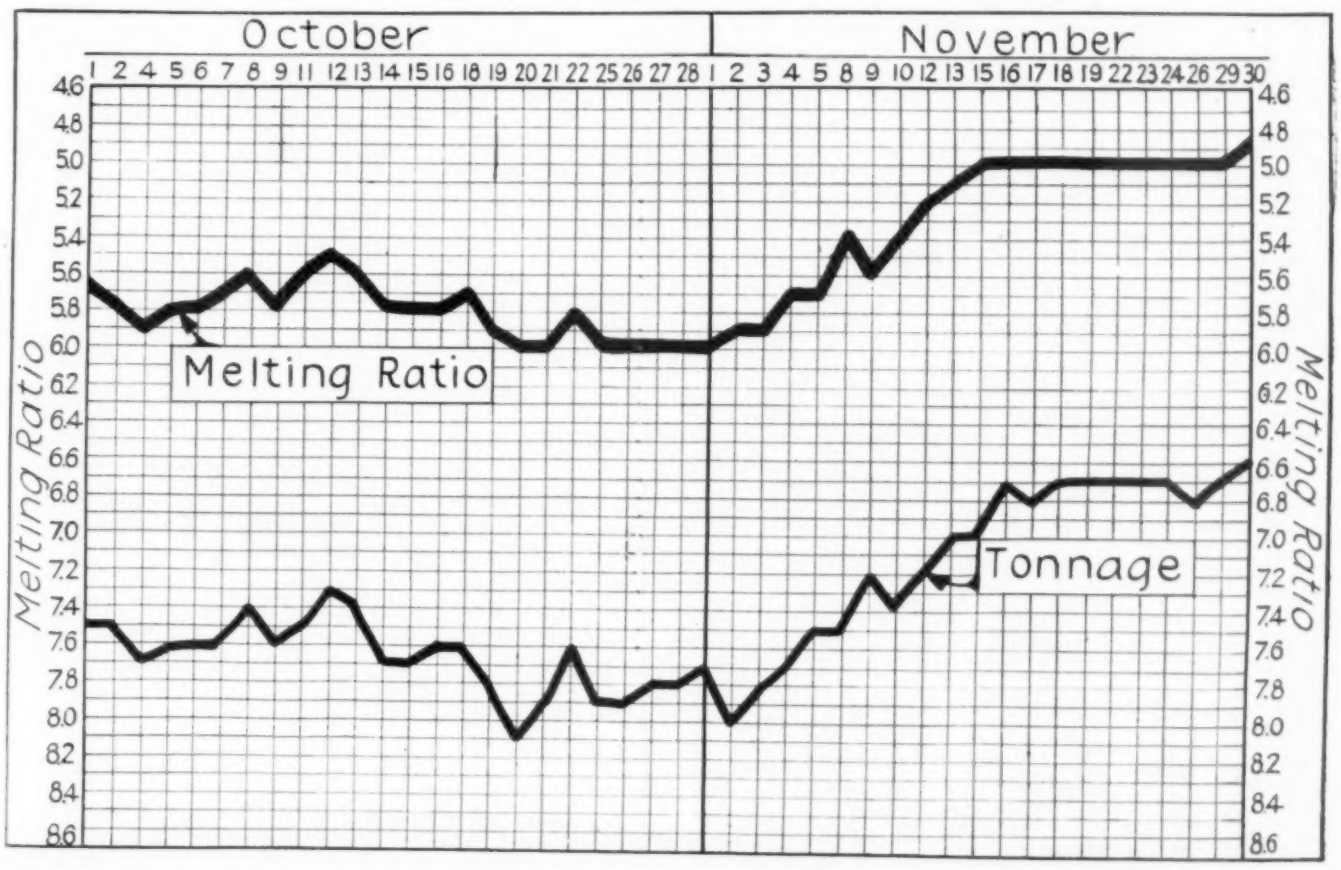


FIG. 1—IN THIS CHART THE UPPER CURVE REPRESENTS THE MELTING RATIO AND THE LOWER CURVE SHOWS THE TONNAGE MELTED

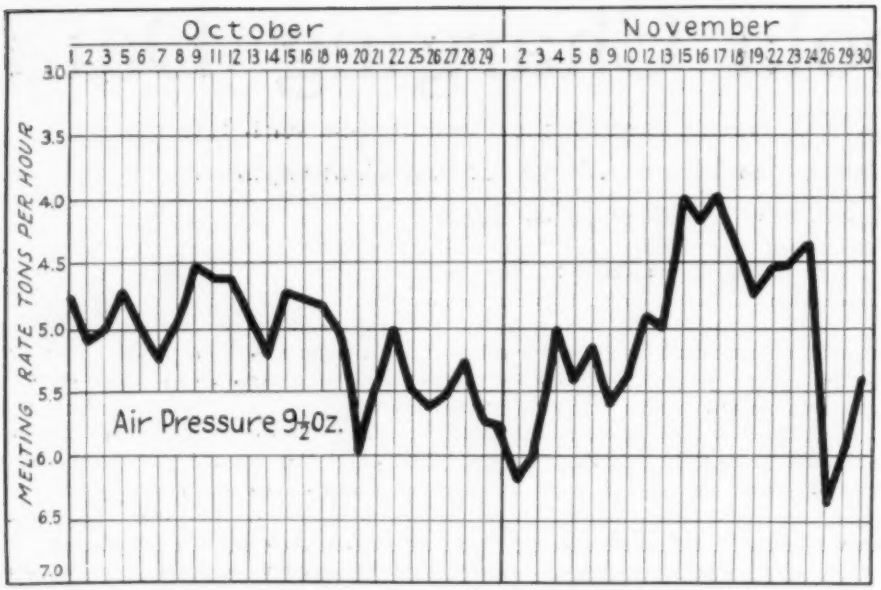


FIG. 2—MELTING RATE CURVES FOR TWO MONTHS OBTAINED FROM A CUPOLA LINED TO 32 INCHES

blank designed by the writer is shown in the illustration Fig. 4. It carries the desired information in more or less recapitulated form, but sufficient detail is presented to permit an intelligent analysis of the cupola performance. At the top of the report appears the heat number, the cupola number, where more than one cupola is in use and, the date of cast. In later report forms I am having an extra column added at the right hand edge for placing the percentages. Each item then will be shown as a percentage of the whole. Percentages generally convey a better idea of relative weights than the actual weights in pounds. The following is a detailed explanation of each section of the report.

Pig iron generally is purchased according to its chemical analysis furnished by the furnace and verified by the foundry chemist. The old practice of grading irons by fracture is practically obsolete. With long experience in using the same brands of pig made from the same ores, grading by fracture may be followed with fairly uniform results. However, the foundryman rarely knows when some change is made at the blast furnace and should a heat be lost due to unsatisfactory iron, considerable loss would result. Physical as well as chemical tests are desirable but the latter are essential to continued success. The writer keeps on record the furnace analysis of each car of pig received and in addition another analysis made in the following manner. A sample is taken from each car, six pigs being selected in such manner as to be a fair representation of the car load. Each pig is broken in two and drillings are taken at a point about half way between the center and the outer surfaces of the six pieces. Sand and scale are kept out of the drillings by placing a piece of paper over the end to be drilled and drilling through this paper. The drillings are carried up by the drill and deposited on the paper.

Equal amounts of these drillings then are taken from the six pigs and thoroughly mixed. A sample of about one ounce then is taken, sealed in a heavy envelope upon which is recorded the car number, brand of iron and date of shipment and sent to the chemist for analysis. Upon receipt of the analyses from the chemist they are checked against the furnace analyses. The analyses taken in this manner are used in figuring the mixture.

Iron Mixture

In the production of any class of castings two specific problems present themselves: (1) The production of cast-

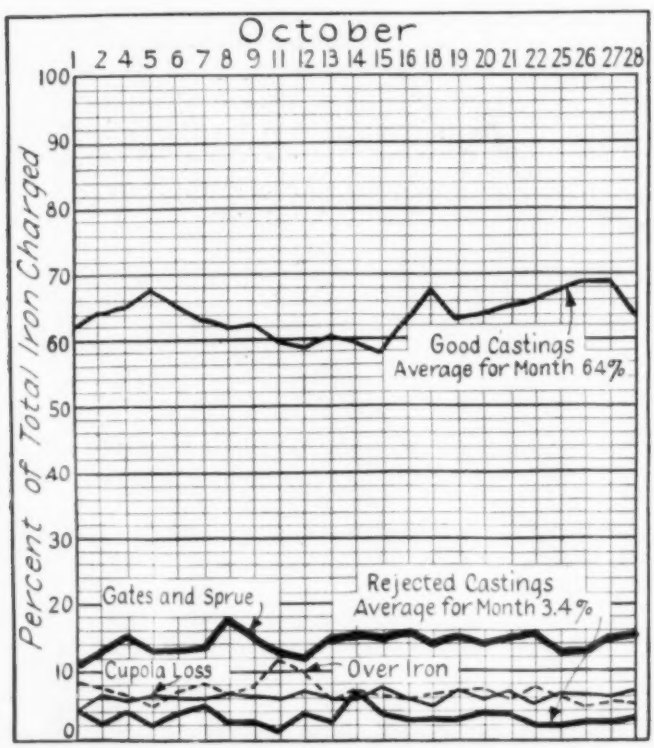
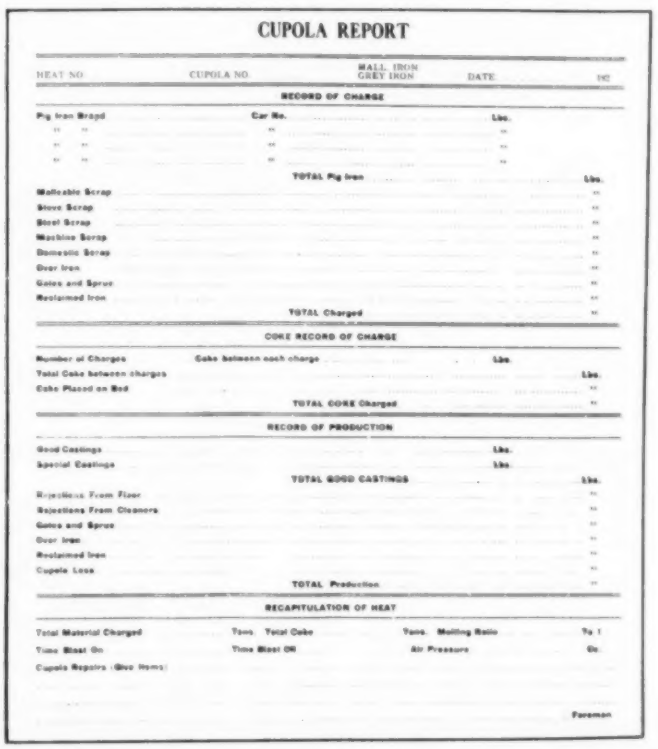


FIG. 3—AN ANALYSIS OF PRODUCTION FOR ONE MONTH—EACH OF THE VERTICAL LINES REPRESENTS ONE HEAT AND THE HORIZONTAL LINES REPRESENT PERCENT



CUPOLA REPORT

HEAT NO. CUPOLA NO. MALL IRON / GREY IRON DATE 192

RECORD OF CHARGE

Pig Iron Brand Car No. Lbs.

TOTAL Pig Iron Lbs.

Malleable Scrap
Stove Scrap
Steel Scrap
Machine Scrap
Domestic Scrap
Over Iron
Gates and Sprue
Reclaimed Iron

TOTAL Charged

COKE RECORD OF CHARGE

Number of Charges Coke between each charge Lbs.

Total Coke between charges Lbs.
Coke Placed on Bed

TOTAL COKE Charged

RECORD OF PRODUCTION

Good Castings Lbs.
Special Castings Lbs.

TOTAL GOOD CASTINGS Lbs.

Rejections From Floor
Rejections From Cleaners
Gates and Sprue
Over Iron
Reclaimed Iron
Cupola Loss

TOTAL Production

RECAPITULATION OF HEAT

Total Material Charged Tons. Total Coke Tons. Melting Ratio To 1
Time Blast On Time Blast Off Air Pressure Oz.
Cupola Repairs (Give Items)

Foreman

FIG. 4—IN ADDITION TO THE ITEMS TABULATED FUTURE FORMS WILL CARRY A COLUMN AT THE EXTREME RIGHT FOR PERCENTAGES

ings having the proper physical characteristics; (2) the production of castings at the lowest possible cost. To obtain the proper physical characteristics several grades of pig generally are used in the same mixture together with a definite amount of machine scrap, steel scrap, foundry rejections or as they generally are known domestic scrap, gates and sprue, and foundry pigs. It is essential to have on hand an analysis of all the materials charged. The analysis of the domestic scrap is taken from the heat as produced. Analysis of purchased scrap is obtained by taking average samples and having analyses made of the drillings. In the absence of this analysis the following standard analysis is assumed: agricultural gray iron scrap; silicon 2.00 per cent, manganese 0.50 per cent, phosphorus, 0.60 per cent; sulphur, 0.1 per cent.

Figuring the Mixture

The form of mixture sheet used and the method of calculation employed is shown in Fig. 5. The iron on hand in the yard is recorded on a separate sheet on which is shown the amounts of the various elements in pounds per hundred pounds of pig. This facilitates figuring the iron for a particular mix. For example consider figuring the silicon for a 1000-pound charge of gray iron mixture which is to have approximately 1.95 per cent silicon. From past records domestic scrap shows an average of say 2.00 per cent silicon. Purchased scrap also is taken as possessing 2.00 per cent silicon. If the charge is to have 60 per cent scrap and 40 per cent pig iron then there will be 600 pounds of scrap containing 12 pounds of silicon. The total charge must have 19.5 pounds of silicon plus whatever amount of silicon may be burned out in the cupola. From past performance we find that this amount is about 10 per cent and therefore the charge must have 21.7 pounds of silicon. The pig iron must contain 21.7—12, or 9.7 pounds of silicon. We then can figure the remainder of the elements on the same basis and then select irons from the yard supply that will fulfill the requirements. The amount of sulphur taken up from the coke is obtained by checking back on prior heats. This amount will be found to vary with the amount of manganese in the iron, the greater the amount of manganese present the less sulphur will be absorbed and the more sulphur will be carried off in the slag as manganese-sulphide. The ratio between the total amount of sulphur in the coke and the amount absorbed depends on the kind and quality of flux used, the temperature of the iron and the composition of the coke and iron.

A certain amount of silicon and manganese is lost in the melting process, the loss in silicon ranging as high as 15 to 20 per cent and manganese as high as 15 per cent. Manganese passes off in the slag as manganese sulphide. Silicon loss generally is due to excess blast and is a good key to blast conditions. The loss of silicon depends on the amount of silicon in the iron, ranging from 20 per cent in iron containing 4 per cent silicon to an imperceptible quantity in irons low in silicon. The oxygen of the blast converts the silicon into silica. For a proper discussion of the influences of the various elements the reader is referred to standard works on foundry chemistry. A thorough understanding of the functions of the various elements is necessary to the successful operation on the foregoing basis of figuring mixtures.

After the mix sheet calculations are completed a copy is turned over to the cupola tender who supervises the making up of the charges. Incidentally each car of pig as received is piled separately in the yard with the car number posted on each pile. This enables the cupola tender to identify the irons called for on the mix sheet, by car numbers and brand. Each charge is delivered to the charging floor separately and is kept separate thoughout. The charging floor is divided into sections for charges with a charge number posted on the wall. Trucks or cars especially designed for the purpose and having a known weight are loaded in the yard with the required iron, run onto a platform scale and stripped to weight. They, then are delivered to the charging floor and spotted opposite the proper charge number. A separate car contains the required amount of scrap, including the foundy scrap, which is proportioned among the charges in such manner that all scrap produced on one day is used the following day.

The total pounds of the various irons are posted direct to the cupola report by the weigh clerk. The total amount of foundry scrap, gates and sprue and pigs from the pig beds are posted from the production report of the day before. The manner in which these quantities are obtained will be explained later. The amounts of other scrap are obtained by scale weights as these materials are delivered to the charging floor. In this connection the scale is located so that no material can pass to the charging floor without passing over the scale. The clerk figures the per cent of each item and shows the total charge in the proper place on the report.

This section of the report is self explanatory. The coke is delivered to the charging floor over the scale and piled in a bin large enough to hold about fifty per cent more than needed for a normal heat. This excess coke is provided to take care of any emergency that may arise. The following morning the clerk or some one competent to judge, visits the charging floor and estimates the amount of coke carried over. This estimate is made fairly accurate by checking the size of bin with a known weight of coke. To obtain the amount of coke on the bed and between each charge without weighing it a second time a standard coke fork is used having established the weight of coke per forkfull. The number of forkfulls used on the bed or between the charges then are chalked up on a slate by the cupola tender and this record is taken by the clerk who checks it up with his own observations.

Analyze Samples

As each car of coke is received, samples are taken and analyzed by the chemist to determine the per cent of ash, sulphur and volatile matter. This, in connection with the other elements of the cupola report, enable the man in charge to check up the cupola performance and furnish specifications to the purchasing department for future shipments. The coke used is identified by the car number posted over the pile in the yard and entered on the report by the clerk.

The manner of firing the cupola and charging the coke has much to do with fuel economy. The best practice probably is to charge one-half of the bed coke and allow this to burn through before charging the remainder. As soon as the fuel burns up evenly, that is thoroughly afire all around the sides, the iron may be charged. The time required for the coke to burn through varies with the draft. In many foundries this period is hurried along by the aid of forced draft which is often times a detriment to the cupola lining. By allowing the bed to fire up with the draft through the breast, the temperature of the lining will rise and therefore the life will be prolonged. A loss of fuel will result, if the bed burns longer than absolutely necessary. The amount of coke required on the bed depends on many factors among which may be mentioned, density of coke and height of tuyeres. The denser the coke the lower may be the bed. The bed generally extends from 18 to 24 inches above the lower tuyeres. A practical method of testing the depth of coke bed is to observe the length of time between the time of blast on, to the time a stream of metal runs from the tap hole. This time should be from 8 to 10 minutes. If less than 8 minutes have elapsed the bed probably is too light and if more than 10 minutes, the bed probably is too heavy. Drops of iron may

RECORD OF MIXTURE # 26

Grey IRON USE FROM 2/1 192 0 TO 2/24 192 0

Car No.	Brand	Per Lbs charge	% Silicon	Lbs Silicon	% Man.	Lbs. Man.	% Phos	Lbs. Phos.	% Sul.	Lbs. Sul.
30145	II	83	2.48	2.058	.58	.48	1.112	.923	.022	.0183
42136	XXX	250	2.07	5.175	.70	1.75	.206	.515	.035	.0875
F Mang.		2			70	1.40				
PURCHASE SCRAP		417	2.00	8.34	.50	2.085	.70	2.919	.100	.417
DOMESTIC SCRAP		250	2.00	5.00	.50	1.250	.75	1.875	.100	.250
TOTAL POUNDS		1000		20.573		6.965		6.232		.7728
GROSS ELEMENTS				20.573		6.965		6.232		.7728
LOSS BY OXIDATION			5%	1.029	10%	.696				
SULPHUR GAIN (Melting ratio to 1			30% gain from Coke equals							.4275
NET ELEMENTS			1.95	19.544	.63	6.269	.62	6.232	.12	1.2003
ANALYSIS DESIRED			1.9-2.1		.6 - .7		.6-.7		less than .1	

RETURNS FROM CHEMIST ON TEST BARS

Date cast.	Heat No.	% Sil.	% Man.	% Phos.	% Sul.	Date cast.	Heat No.	% Sil.	% Man.	% Phos.	% Sul.
2 1	22	2.04	.51	.579	.121	13	33	2.14	.55	.498	.103
2	23	1.97	.74	.591	.108	14	34	2.02	.43	.517	.104
3	24	2.13	.68	.606	.133	15	36	2.03	.45	.564	.123
5	25	2.05	.60	.550	.118	17	37	2.10	.41	.610	.113
6	26	2.17	.66	.561	.106	18	38	2.07	.48	.563	.120
7	28	2.04	.62	.595	.093						
8	29	1.99	.58	.551	.117	Mixture changed due to mang, running					
9	30	2.21	.57	.544	.096						
10	31	2.04	.56	.511	.120	low. See mix # 27					
12	32	2.06	.62	.521	.108						

FIG. 5—THIS SHEET SHOWS THE FORM OF MIXTURE SHEET USED AND THE METHOD OF CALCULATION EMPLOYED

appear at the tap hole from 3 to 4 minutes after the blast is put on.

The amount of coke between charges should be sufficient to make a layer 4 to 6 inches deep. After the heat has been taken off the region of highest temperature will be indicated on the cupola wall by scored lining. If this scored section is from 4 to 6 inches wide, the proportion of iron and coke charged is about correct. However, if this section is over 6 inches in width a change is necessary. If upon changing the coke charge the next heat shows the scoring to have moved up the cupola lining, the coke charge is too large; whereas if it has moved down it is too light and later changes to correct this should be made. A practical way to determine the amount of coke to be used, is to make a brick circle on the floor the diameter of the lining of the cupola and from four to six inches in height. Fill this with dry coke and weigh the amount. The charges of iron may be made about ten times as heavy as the charge of coke.

Another means for checking the coke charge is to time the melting. If the amount of metal melted during a given period of time gradually decreases as the melting continues, the coke charges may be reduced with safety. This is because the cupola becomes thoroughly heated after a while and more heat units are available for melting the iron than in the earlier charges. The amount of such reductions must be found by experiment.

Record of Production

Under this heading is summarized the total iron divisible into iron that is poured into the molds and iron that for various reasons does not reach the molds. The latter consists of such iron as may be too cold to pour into molds and is poured into pig beds; used to heat the ladles and poured into shop rigging, reclaimed iron from the slag and cupola drop and the cupola loss. Iron poured into the molds is divided into production castings, gates, and sprues. Inspection of the product is divided in two phases; floor inspection, and inspection after cleaning. After the molds have been dumped and the castings taken from the sand, the gates and sprue are knocked off, or cut off. The castings also are given an initial inspection for apparent defects such as cold shuts, blows etc. The castings then are delivered to the cleaners and afterward inspected a second time. This inspection removes all defective castings not caught in the first inspection with the exception of such as may show defects after machining. The accepted castings then are weighed and this weight is entered in the space provided. A line also is provided for special castings such as die blocks etc.

The rejected castings then are weighed and the weights recorded on the report. All gates and sprue are milled before weighing. This not only provides an accurate weight of the iron but produces cleaner iron. Incidentally, scrap heavy with rust and dirt is milled before charging and it is believed that better iron is the result. Figures for cupola loss are obtained by subtracting the total weight of all known quantities from the total iron charged. The percentage of each item then is figured and set down in the column provided.

Recapitulation of Heat

The total material charged including coke is brought down in tons. The melting ratio is the quotient obtained by dividing the tons of melting charged by the tons of coke charged. The melting ratio varies with the tonnage melted. One foundry may pour only 4 or 5 tons in a heat, using a 40-inch cupola, while in another foundry as high as 50 or 60 tons may be poured from the same size cupola in one continuous heat. Each of these foundries may have the same class of fuel and iron yet the melting ratio may be widely different. Obviously it requires the same bed in each instance and assuming that the same amount is used between charges of iron, the ratio in the second case will be higher than in the first. Say the bed requires 1000 pounds of coke and that 200 pounds are charged under each 2000-pound charge of iron. The first foundry will pour 10,000 pounds of iron and consume 1800 pounds of coke giving a melting ratio of 1 to 5.5 whereas the second foundry will pour 100,000 pounds of iron consuming 10,800 pounds of coke giving a melting ratio of 1 to 9.2. This difference in the ratio is due to the fact that it requires just as much coke on the bed to heat up the cupola for melting one ton of iron as it would in case a heat of fifty tons were to be poured. The iron should be hot regardless of ratios. If not, bunged ladles and cupola will result.

Approximately 30,000 cubic feet of

free air are required per ton of iron melted and the pressure varies from 8 to 16 ounces per square inch. The writer installed a set of continuous tuyeres in a cupola about a year ago and the cupola is giving good satisfaction with a blast pressure of from 8 to 9 ounces per square inch. It is not good practice to try to increase the melting ratio by an increase in the blast pressure as this raises the melting zone, causing the charge to melt below this point. On the other hand, lowering the blast, lowers the melting zone, and the charge melts above the zone. The location of the melting zone definitely should be determined for the size of cupola and a blast pressure used will give the most efficient results. The hottest point in the cupola is where complete combustion takes place, or in other words, the point where the product of combustion is carbon dioxide gas. In a 30-inch cupola this point is about 19 inches above the tuyeres. The entering air combines with the carbon of the fuel and at the point referred to forms carbon dioxide, but upon passing up through the incandescent fuel, more carbon is picked up, changing the gas into carbon monoxide gas. This gas is visible in the upper part of the cupola where it burns to carbon dioxide above the last charge and represents waste heat. To burn 1 pound of carbon to carbon monoxide 4400 heat units are liberated but when this same carbon is burned to carbon dioxide 14,500 heat units are liberated. The blast pressure is valuable data and often presents a clue to inefficient operation. For this reason I have insisted that the average blast pressure of the heat be recorded on the cupola report. Repairs is another item of importance in securing maximum economy in the cupola performance and is the most difficult data to obtain. I cannot say that this part of the report has worked out satisfactorily so far. However, I believe that in time this data would present some interesting information.

Among the repairs that should be reported, are building of the breast, new linings, repairs to the lining, tuyeres etc. Anything around the cupola requiring fixing up from time to time preparatory to taking off a heat.

Apply the Data

The final point of consideration is the method of using the data obtained from the cupola report. Many times the utilization of data is the stumbling block, and data that otherwise would be of value often is cast aside for the need of some presentable form in which it might be worked up to advantage. The presentation should be comprehensive and on a comparative basis. The accompanying charts show the data collected on the cupola report, charted in such manner that the performance may be studied and results noted at a glance.

The chart shown in Fig. 2 shows the melting rate curves for two months obtained from a number 4 Whiting cupola lined to 32 inches, operated with an air pressure of 9½ ounces while the chart Fig. 1, shows the melting ratio for this same period in the same cupola. The lower curve on this chart is the tonnage melted. Note that the two curves run nearly parallel. Chart 3 shows an analysis of production for one month identical with the first section of the preceding charts. Each of the vertical lines represent one heat and the horizonal lines represent percentages.

By means of the cupola report analysis charted on cross section paper, the performance may be checked carefully and rapidly. Changes may be made here and there based on past performance and tending to increase the general efficiency. These are the type of records that the writer has kept for the past two years and so far I have failed to find them a burden. They have proven of great assistance in reducing the cost of production in the foundry. It is possible that these records may be of assistance to others responsible for efficiency in the foundry or at least suggest some better method of reaching the desired result.

Making Malleable Castings—II

(*Concluded from page 626*)

Many are troubled owing to their inability to obtain a sand sufficiently free from bases to avoid the fusion of the sand to the surface of the castings so tightly that cleaning is made difficult. It is interesting to note that in cases of this kind in which, in spite of drastic tumbling, a crust of sand still adheres, particularly at fillets or recesses, that a short application of the cutting torch will speedily remove it, owing to the difference in the rate of expansion of the crust and the iron.

Regarding losses the following is representative. In general automobile work the hard and soft-iron losses will approximate 15 and 4 per cent respectively. While the latter may seem high, inspection is extremely rigid and the losses that result from straightening are not inconsequential, while defectives returned by the purchaser will often run as high as 2 per cent. It is safe to say that 20 per cent of the castings poured are rejected at one stage or another. In the case of railway work the losses are not as heavy, and will not exceed a total of about 9 per cent, and while the inspection to which these castings are subjected also is rigid it is not so exacting as in the case of the other. In agricultural work the average loss will approximate 5 per cent. In addition to the foregoing it is well to estimate that the loss due to grinding will prove to be about 1 per cent.

Expresses Appreciation

To THE EDITORS,

Will you kindly thank, through your paper, all the members of the American Foundrymen's Association for their friendly welcome in Rochester and elsewhere.

If the foundrymen or foundry ware dealers wish to obtain any information regarding the possibilities of business in Europe, they may write to me, and I shall be very glad to advise them.

Very truly yours

M. REMY,

Ateliers et Fonderies, Herstal, Belgium

Metal Mining Center in Illinois

The geographical center of metal mining of the United States is in eastern Nebraska, about 20 miles west of York, the bureau of mines has determined. The common belief has been that Arizona, Montana or Idaho is the center, but the iron ore mines of Michigan, Minnesota and Wisconsin and the Mississippi Valley lead and zinc mines pull the point eastward, the bureau points out. For the coal mining industry the geographic center is 30 miles northeast of Chillicothe, O., and for the entire mining and quarrying industry of the United States about 10 miles south of Springfield, Ill.

Issues Foundry Data

Debevoise-Anderson Co., 140 Liberty street, New York, has published a booklet entitled "Foundry Facts" written to be of service ot foundrymen. This booklet contains a great deal of interest stated in a concise simple manner. Brief articles are given on the reactions of carbon, silicon, phosphorus, manganese, and sulphur, in castings. There also are several pages taken up with "helpful hints" on practical foundry problems and various tables containing information.

Improvements in the process of liquefying air and then distilling off the nitrogen and retaining the oxygen enable the latter to be produced so cheaply that it offers great possibilities in metallurgical processes.

Bronze Casting in the Orient

Differing Slightly in Detail but with the Same General Features, Castings and Their Methods of Production Have Remained Practically Unchanged for Over 3000 Years

BY PAT DWYER

ACCORDING to Chinese history the art of founding in metals first was practiced in that country in the dynasty of Hia, or approximately 2200 B. C. Considering the long intervening stretch of 4000 years, the manner in which the country was self-isolated from the remainder of the world during the greater part of that time, the comparatively meager knowledge of its history, habits and customs possessed by outside nations even today, the difficulties and mistakes incident to translation of a language with over 3000 written characters and with 5000 varieties; it is impossible to determine where history merges into tradition, legend and fable. Accepting evidence submitted by eminent oriental scholars it appears that a ruler Yu who flourished during the Hia dynasty, had nine immense Dings or sacrificial vessels, cast in bronze, bearing on their outer surface representations of birds and animals and a scale map of the country illustrating the manner in which he had controlled and directed an immense flood which at one time threatened to destroy all living creatures. This, of course, has reference to the Chinese version of a story, or tradition, familiar in one shape or another among all races of men, civilized and savage. The Aryan version is based on the story of Noah as it is presented in the Book of Genesis. Dings made in recent years average 5 or 6 feet in height. They are hollow on the inside and are provided on the outside with two handles and three legs. Although no dimensions are available, the nine Dings made by Yu must have been of an immense size for according to tradition they weighed what is equivalent to 40,000 pounds each and all the bronze in the country was collected and melted to pour them. Attempt to verify the date on which bronze castings first were made in China would serve no useful purpose, but from even the most superficial evidence it is apparent that the art was known and practiced many centuries ago. Specimens, undoubtedly centuries old, some of them indeed, antedating the Christian era, still are extant in the shape of cooking utensils, weapons, agricultural implements, musical instruments, temple bells, mirrors, candle sticks, incense burners, etc. Adoption of fads and fancies, changes and innovations never have appealed to the Chinese. Their minds work in slow, accustomed grooves and have nothing in common with the hectic occidental mind, forever seeking change and variety in clothes, food, entertainment, manufacturing processes and methods of transportation. The ways of their ancestors are good enough for them and they see no reason for departing therefrom. However, although there is no record of swift and startling changes, oriental scholars have discovered that the huge blanket of inertia has billowed occasionally. Not abruptly, but mildly and gently the undulation has started probably at the beginning of one of the 50 dynasties into which the history of the country is divided, it has flowed along steadily and smoothly for from 100 to 500 years and then silently and without a struggle has rolled in and been dissipated on the long shelving beach of an incoming dynasty that offered no resistance. Thus, it has been found that while the methods of the Chinese metal worker have remained the same for at least 25 centuries, and while he has confined his efforts to producing articles of the same size and shape during that time, nevertheless he has varied some of the minor details occasionally. These details though apparently slight and insignificant are sufficient to fix the date of the manufacture of the article within certain definite limits, these dates corresponding with the inception and fall of one dynasty. For instance at one period all the figures and characters designed for ornamentation on an article were depressed below the surface while at another period the same figures and characters were shown in relief above the surface. The Bureau of Economic Information, Pekin, Republic of China, quotes Professor Chen Teh Yuen, B. S., Soochow university, to the effect that Chinese coppersmiths still are using the methods and implements handed down for countless generations. Speaking of a local shop visited in the city of Soochow (Kiangsu) the professor is quoted further as saying: "The furnace was about 3 feet high, 6 feet long, 5 feet wide, rectangular in shape and built of bricks 1½ feet square. Crucibles

FIG. 1—REPRODUCTION OF A BRONZE GONG MADE DURING THE T'ANG DYNASTY THE ORIGINAL IS IN THE KOFUKUYI MONASTERY, NARA, JAPAN

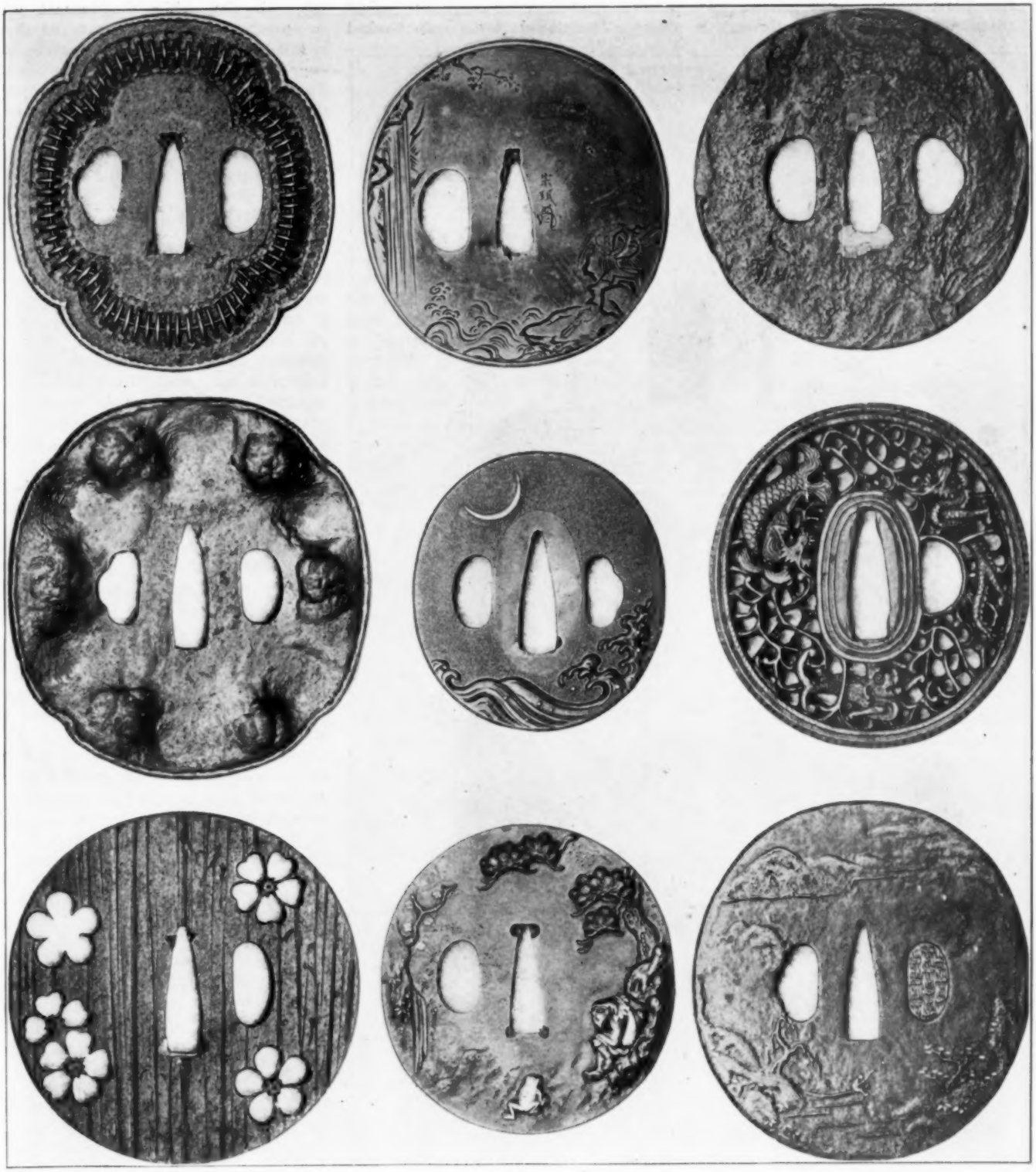


FIG. 2—EXAMPLES OF JAPANESE SWORD GUARDS MADE ABOUT THE MIDDLE OF THE 19TH CENTURY

were buried in a coal fire in the 2-foot wide space between the side walls and filled with scraps of what is known locally as yellow copper, derived from vessels that had outlived their usefulness. A hand bellows, made of a special clay, dirty white in color, attached to one side of the furnace was employed to furnish a blast to accelerate the melting. The whole outfit in effect conformed to the ordinary blacksmiths fire. The crucibles were not covered and no chimney was provided to carry away the fumes, or to induce a draft through the fuel. After the metal was melted the crucibles were lifted out of the furnace with long iron tongs and the contents poured into clay molds which produced rectangular slabs of metal about 12 x 12 inches, 1 inch thick. These slabs afterward were hammered down into thin sheets and made up into various forms as desired.

In another shop visited, white copper was manufactured from red copper, zinc and nickel, melted in a small circular furnace built of brick and clay covered with a thin sheet of iron. The furnace was about 2½ feet high, outside diameter 18 inches, inside diameter 10 inches. A set of firebars about 1 foot from the bottom supported the fuel. The space below the bars served for an ashpit, access to which was had through a small hole in one side of the

wall. Blast from a hand bellows was introduced under the grate through a second smaller hole above the ashpit door. The lower hole was banked up with clay while the furnace was in operation. The best grade of alloy is made up by melting 2 catties of copper, 1 catty zinc and 1 catty nickel. For an inferior grade the same proportion of copper and nickel is used but the zinc content is increased to 1½ catties. The weight of a catty varies to some extent here and there in far eastern countries, but by the terms of a treaty adopted at the time China was recognized as a republic, the weight was established at 1 1/3 pounds. At the present time scrap copper and zinc are used almost exclusively, partly on account of the price and partly on account of the scarcity of new metals. Before the outbreak of the European war, most of the nickel was imported from Austria, since that source of supply has been cut off, Japanese nickel has been employed extensively.

FIG. 3—THIS BELL WHICH STANDS ABOUT 3 FEET HIGH WAS CAST NOT LATER THAN THE MIDDLE OF THE 5TH CENTURY A. D.—THE ORNAMENTAL DESIGN IS ALL IN RELIEF

"The pink crucible, 6 inches high, 5 inches in diameter, 3/10-inch thick, with a slightly rounded bottom and with a capacity of 6 catties, (9 pounds,) was made of Nieshen clay and buried in a fire of anthracite coal from Honan. The copper and nickel were charged first and melted. Then the crucible was lifted out of the fire and the zinc was added. Before lifting the crucible from the fire, one of the workmen stirred the contents with an iron rod to insure a homogeneous mixture. The contents of the crucible were poured into a small ingot mold and the block of metal thus secured was removed after it had cooled, either to be sold in that shape or to be worked down into other forms on the premises. The crucible was returned to the fire and recharged. Each melting occupied approximately 1 hour."

Literature Is Vague

It will be noted the professor does not refer to foundry melting. Published literature on either ancient or modern Chinese bronze art work is delightfully vague from a foundry standpoint. The accompanying illustrations are from photographs loaned by the Cleveland Museum of Art where the originals are on exhibition in the Oriental section. Some of these castings are owned by the museum and others form part of the collection of Worcester R. Warner, Cleveland, scientist, engineer, manufacturer of scientific and precision tools and instruments and in his spare time, student of oriental art.

The bronze gong shown in Fig. 1 is a reproduction of an original made during the T'ang Dynasty and at present in Kofukuyi Monastery, Nara, Japan. It is remarkable not only for the beauty and symmetry of design but the intricate detail of ornamentation

reflects credit on the artist who made the model and the workman who translated it into enduring bronze. In all probability one man carried the work through from the conception of the design to the final polishing of the casting. Plaster of Paris and gelatin molds were unknown to the ancients. In many cases they formed their mold directly from the model and in other cases a great deal of the ornamental work was done by stamping a design or a repetition of a design on to the face of the mold after it had been removed from a plain pattern. The casting apparently is all of one piece. It is possible it may have been cast in several sections and afterward brazed together, but if so the jointing has been done so skilfully as to defy detection. Further, the casting is only a shell, a fact easily determined by rapping on the outside or by trying the weight and yet no openings are visible any place through which the core sand could have been cleaned out. The *lost wax* process is employed extensively throughout China and Japan and though there is no definite method of determining when it first was introduced or practiced, the character of some of the ancient castings leaves no doubt that they were produced in that manner.

In the modern method of applying the lost wax process to the production of castings, a master mold first is made in plaster of Paris. This precaution is observed for two reasons, first, if anything should go wrong with the casting process, the plaster reserve mold would eliminate the necessity of building up another expensive model; second, frequently more than one casting is ordered from a designated model and the plaster mold may be employed to make as many wax impressions as required.

The Oriental metal worker had no such insurance clause in his contract. He built up his clay core approximately to the size and shape of the desired casting. Upon this foundation he laid a thin coating of wax molded and shaped under his skilful fingers into a representation of what he wanted to perpetuate in metal. During the dynasty, as previously mentioned, it was customary for the artist to superimpose ornamental figures and characters on the surface of the wax pattern and as a result the metal reproduction carried these various figures and characters in relief. At another period the artist stamped or carved his figures and characters on the wax surface and the casting made from this pattern showed the design below the surrounding surface. Many of the depressions produced in this manner afterward served to hold inlay made of gold or other material.

After the wax model was finished the artist painted it with a thin clay

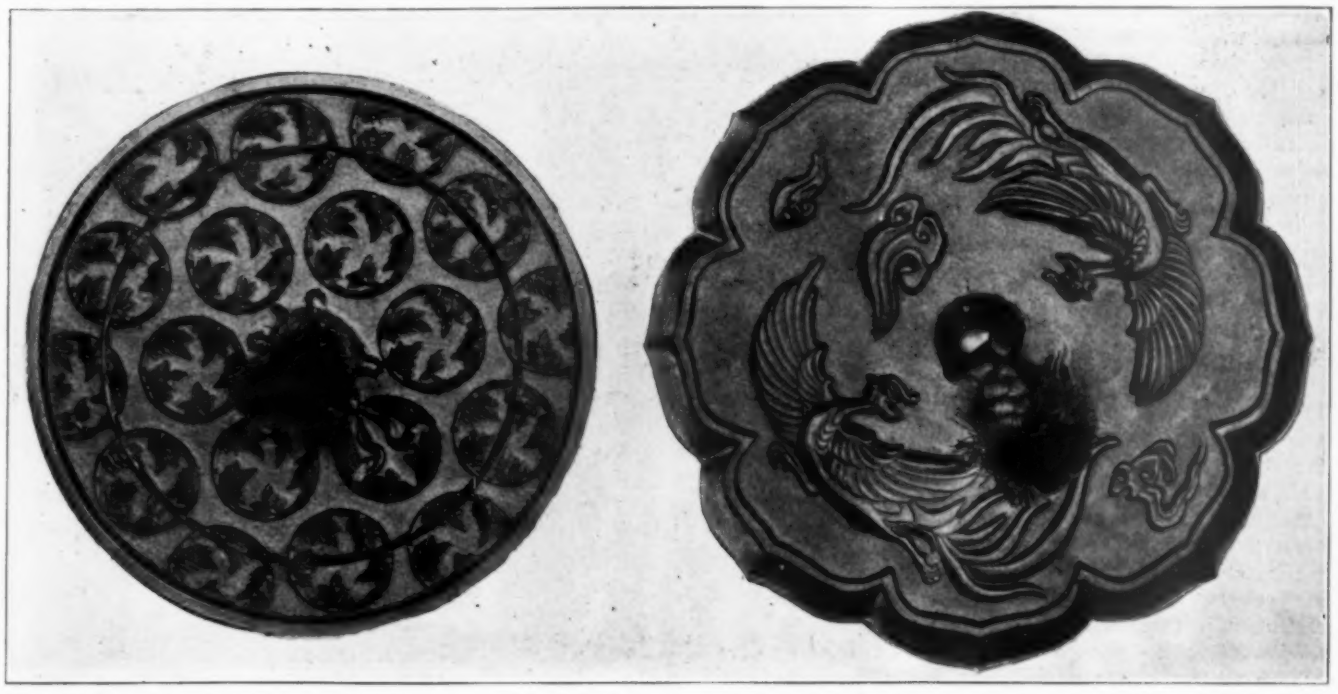


FIG. 4—IN THE UPPER LEFT HAND CORNER OF THE PAGE, FIGS. 5 AND 6 BELOW AND FIG. 7 IN THE UPPER RIGHT HAND CORNER ARE BRONZE MIRRORS HIGHLY POLISHED ON ONE SIDE AND BEARING ELABORATE RELIEF DESIGNS ON THE OTHER SIDE--EACH MIRROR IS PROVIDED WITH A SILKEN CORD AND TASSEL

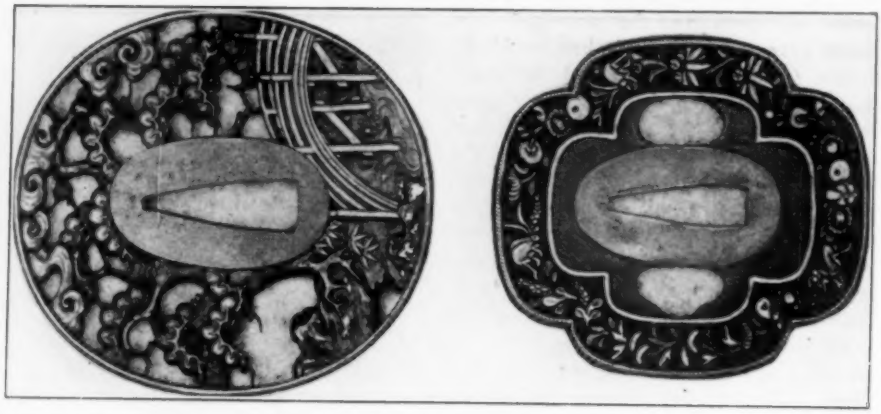


FIG. 8—FURTHER EXAMPLES OF JAPANESE SWORD GUARDS, ALSO SHOWN IN FIGS. 10 AND 11

wash, this was followed by several coats of increasingly stiffer mud, or loam, and when he was satisfied that the wall of the mold was strong enough, he either placed it in an oven or built a fire inside the core, depending on the size of the mold. The mold was heated to a point that expelled the last particle of wax and then was buried in a pit and rammed up solidly all around with sand to withstand the pressure of the metal employed to fill the cavity left in the mold when the wax drained out. If for any reason the casting operation was not a success the entire job was a total loss. The artist had to start at the beginning and prepare all three parts, core, pattern and mold, over again.

The Chinese sacrificial vessel shown in Fig. 11, was made during the Chou Dynasty 1122-221 B. C. It stands about 2 feet high, the metal thickness which is remarkably uniform throughout, is ¼ inch. In its original state it was provided with a lid or cover. Owing to its extreme age the ornamental design, extending completely over the exterior surface, is rather faint and the photographic reduction has further reduced its legibleness, but sufficient is discernible to show that the design is sunk into the metal and therefore the pattern must have carried the design in a similar manner. It scarcely is probable that the pattern was plain and the molder or artist attached the ornamentation in relief form to the face of the mold. The hypothesis might be advanced that a complete pattern was employed with the figures carved on the four sides. This would involve splitting the pattern diagonally and the employment of accurately fitting flasks and considering the fact that accurately fitting flasks are yet an unknown quantity in the Orient, it is extremely improbable that they were in existence 3000 years ago.

The bronze bell about 3 feet high shown in Fig. 3, clearly is of another dynasty. As a matter of fact it is credited to a period not later than the fifth century A. D. It will be noted that all the ornamental design is in relief. It is possible that the pattern may have carried this design; but there is also the possibility that a plain pattern was employed and the mold may have been taken apart and finished as in modern practice. It is apparent that the simple design shown might have been scratched in the face of the mold and naturally would show in relief on the finished casting. The position in which the mold was poured also is open to supposition. The logical way, according to a modern view point would be to cast it in the position shown in the illustration. The body of sand forming the interior would support itself and there would be no danger of a *cut through* at any point. The metal thickness is only ⅛-inch and it is apparent that the least move of the core would spell disaster. However, the two small square holes near the crown of the bell would seem to indicate that the casting was poured horizontally, the small body of sand in these holes serving to support one end of the main core. The other end, of course, would be supported in a core

FIG. 9—BRONZE SACRIFICIAL VESSEL ABOUT 2 FEET HIGH MADE DURING THE CHOU DYNASTY 1122—221 B. C.—THE DESIGN ON THE SURFACE OF THIS VESSEL IS DEPRESSED AND IN SOME PLACES BEARS EVIDENCE OF HAVING BEEN INLAID

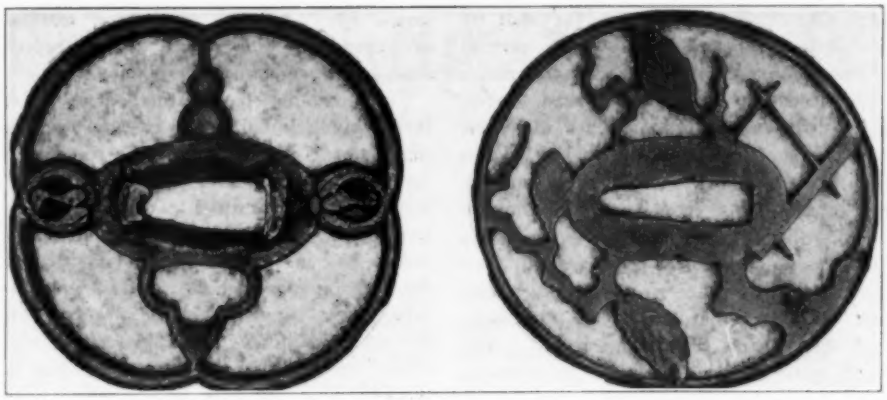


FIG. 10—THESE SWORD GUARDS ARE PERFECTLY FLAT AND PLAIN ON ONE SIDE AND POSSIBLY MAY HAVE BEEN CAST IN OPEN SAND MOLDS OR UNDER SOME FORM OF PERMANENT COPE

print the full size of the opening at the mouth of the bell.

The Japanese mirrors shown in Figs. 4, 5, 6 and 7 were made between the 10th and the 17th centuries A.D. Thus Fig. 6 is credited to the Fujiwara Period 900-1200; Fig. 4, to the Ashikaga Period, 1400-1600; Fig. 7, to the Kamakura Period, 1200-1400 and Fig. 5 to the Ashikaga Period, 1400-1600. The front of these mirrors is highly polished and the back as shown in the illustration is covered with beautiful and symmetrical designs in relief. In addition each mirror is provided with a silken cord and tassel.

The Japanese sword guards shown in Fig. 2, and also in Figs. 8, 10 and 11, are fairly modern, dating from about the middle of the 19th century. Three bear the maker's name, but the others carry no identifying marks of that character. The designs shown in many instances evince a high degree of artistic and technical skill. The outlines are as sharp and distinct as if they had been formed in a die. One side of each casting is perfectly flat and plain and would seem to indicate that the metal was poured into open sand molds. The characteristically rounded edge of the open sand casting is not present, but that is probably due to the fact that the metal was poured exceedingly fluid.

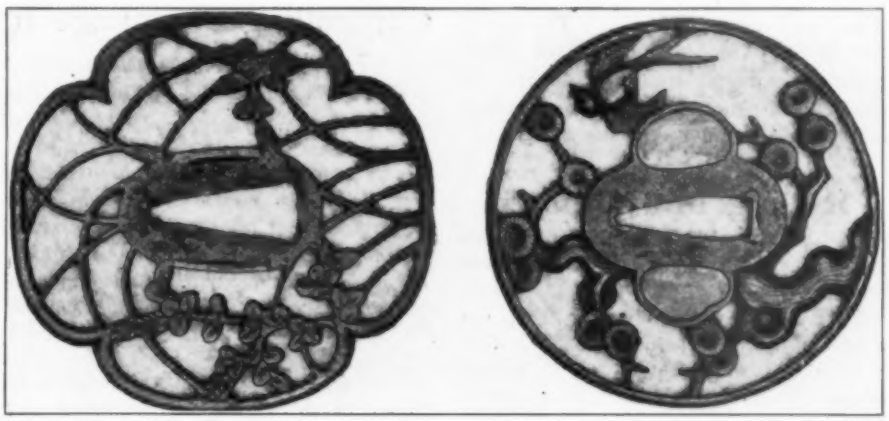


FIG. 11—SOME OF THESE SWORD GUARDS BEAR THE ARTIST'S SIGNATURE

How and Why in Brass Founding

By Charles Vickers

Natural Draft Furnaces for Monel Metal

We have some monel metal castings to make and should like to know what type furnace is best adapted to melting the charge. We have contemplated melting the metal in a crucible in a coke fired pit furnace. By attaching a connection to our cupola blast pipe and discharging air under the furnace we expect to secure the necessary temperature to melt the metal. Do you think the idea is feasible? The castings will weigh from 75 to 400 pounds each and we shall appreciate any suggestions in regard to melting, molding and casting. To what temperature would the metal in the crucible have to be raised?

A good type of furnace for melting any metal having a melting point above that of copper is an oil-fired or gas-fired furnace. The temperature in one of these furnaces quickly can be built up to requirements and kept there without fluctuation for an indefinite period. This is an important point to remember because fluctuation in temperature retards the melting. Wrought iron has been melted in and cast from coke fired furnaces, therefore monel metal also can be melted in such furnaces. However, not only is special skill required to operate a furnace of the character, but the work is hot and arduous, unnecessarily so, and it is difficult to get men to continue at it. The melting point of monel metal is 2483 degrees Fahr. and of course it must be considerably hotter than that to pour castings. The temperature of steel, rising in a mold is approximately 2620 degrees Fahr. or 137 degrees above the melting point of monel metal. From this it is apparent that the pouring temperatures of the two metals is almost alike. It has been demonstrated that a fired furnace only can be expected to melt about 100 pounds of low carbon steel, therefore a similar result may be expected in the case of monel metal and a number of furnaces would be required to supply metal to pour a 400-pound casting.

A natural-draft furnace with a good draft is preferable to one with a blast for melting refractory metals with coke. This is contrary to what one would expect and is due to the fact that a limited amount of fuel is available in the furnace. The blast driven furnace reaches the end of its resources in heat production before the metal is melted. The addition of fresh fuel chills the metal and the process starts over again with only a slight gain from previous work. On account of this feature and also due to the fact that the blast chills the bottom of the pot, blast driven furnaces have not been a success in melting steel and in our opinion the same conditions obtain in melting monel metal.

With a suitable natural draft furnace the following procedure will produce metal fit to pour. Place a base about 8 inches

high on the center of the grate. Cover the base with a layer of coke dust and on this stand the charged crucible, fitted with a cover having a 2-inch hole in the top through which to view the metal. Light the fire around base and crucible and let it burn until the crucible is well heated; now place a half brick over the hole in the cover, then bury the crucible in coke and close the furnace. After a time open the furnace and punch down the top coke around the sides of the crucible cover the crucible with fresh coke and continue until the metal is melted and hot enough to pour. This point may be determined by inspection through the hole in the cover.

Face the molds with a compound made up of silica sand and China clay wet down with molasses water. The molds are dried. One of the monel metal founder's principal troubles is caused by cracked castings due to monel metal contracting ¼-inch to the foot.

Rolling Mill Brasses

We should like to obtain a formula for bronze bearings for rolling mill brasses.

The following formula is used extensively for roll bearings:

	Pounds
Copper	79.75
Tin	10.00
Lead	10.00
Phosphor copper	0.25

Melt the copper under charcoal and when quite liquid add the phosphor copper, stir well and add the tin and lead.

Avoid Shrinkage Trouble in a Bronze Roller

We are making a bronze roller weighing about 500 pounds. The casting comes shrunken and spongy. Where would you suggest it be gated?

The casting will neither shrink nor be porous if it is properly fed by the use of a suitable riser. The best place to gate it is midway on the length of the cylindrical body. The gate should be oval in shape, the oval being set vertically; and half in the cope and half in the drag of the mold at the joint. Make the mold in dry sand, and paint it with plumbago mixed with molasses water. Mix the facing to make a mold like a core when dried and blacked, then no scabbing will occur. As we understand it there is about a 4-inch thickness of metal surrounding the core, therefore, the latter must be protected by rubbing on a paste of plumbago, mixed to the consistency of a dough with strong molasses water. Use the fingers to apply this coat and dry the core afterward. When poured, both core and mold must be warm, even hot. The gate should connect to the root of a 3-inch riser and build it up several inches higher than the top of the mold, using bushings, or dried head cores. Pour down a sprue 1¼ inches diameter, which is connected to the riser. When the mold is filled to the level of the top of the sprue, which will be the top of the flask, cover it over with damp molding sand, and bed on a weight, then slowly fill up the riser bushing with hot metal. This will feed shrinkage and the casting will come sound. The mold must be well secured by clamps; the core must be strongly rodded so it will not spring, and the mold and core thoroughly protected with plumbago.

Controlling Shrinkage in Aluminum

We are making castings from an alloy 89 per cent copper and 11 per cent aluminum. The castings somewhat resemble a bolt with a heavy head and we find, as in the sample sent forward for inspection, that a shrink hole develops at the junction of the head and stem. We are gating the casting at the small end and will appreciate any information that will help us to produce solid castings.

The shrinkage can be controlled by placing a shrink ball on the heavy part of the casting. This ball should be about twice as heavy as the head it is destined to feed and should be wholly in the cope. Turn up cone shaped pieces of wood to serve as feeders and attach them to the heads by round gates half in the cope and half in the drag. An alternative method would be to turn the pattern end for end and attach the gate to the heavy section. A heavy gate extending in the cope above the highest point of the pattern would serve for both runner and feeder.

The discoloration of the skin indicates that some flux is used or that phosphor copper is added. On account of its high pouring temperature aluminum bronze is very active chemically and there are few substances used as fluxes which it will not decompose and produce gases which in turn are absorbed by the metal and result in porous castings. Phosphorus should not be used in any shape. If it is desirable to deoxidize the copper before adding the aluminum, use manganese copper, or iron in the form of tinplate.

Sand Blast for Cleaning Brass Castings

We are making brass castings for mine supplies weighing all the way from 2 to 80 pounds each; also a few pump impellors, and so far we have cleaned the castings by hand using a wire brush. We find this a tedious labor and we would like to know of a good method of doing this work, with special reference to the tumbling barrel method.

The tumbling barrel method is good for cleaning small brass castings, but a casting of 80 pounds would be too heavy for a tumbling barrel running in water and suitable for small castings. If the large castings are few in number it would pay to install a tumbling barrel that is supplied with water and an arrangement underneath for draining off the water without carrying away the fine brass particles. Such a barrel has a wooden lining and is nearly filled with castings, then the skimmings from the hearth, and the scrap brass sweepings of a dirty nature. After the barrel has been run for an hour or more the castings will be clean and polished, and when the barrel has been properly packed, the castings will not be battered.

If the large castings predominate, the best way of cleaning them is by the sandblast. If air under pressure is not available and the machinery to produce the same would have to be installed, the cost of the sandblast might exceed that of the tumbling barrel. The sandblast will clean castings of any size, whereas the tumbling barrel is limited to small castings. Iron castings of comparatively large size are cleaned by tumbling, but in case of the softer brass, the effort to clean large castings by tumbler would be likely to result in battered castings.

Remelting Lead Plates from Batteries

We rerun a good many battery plates in a blast furnace, and are getting an average of 75 per cent of the metal content. We would like to know which is best for this material, a blast furnace, or a reverberatory furnace? We would also know what fluxes are used, if any.

Storage battery plates or grids consist of lead, lead sulphate and lead oxide. The lead content will be between 40 and 50 per cent. A good way to handle this material is first to sweat out the lead in a reverberatory furnace without flux, the sulphate and oxide being left with possibly some lead oxidizing during this process. This material is raked out of the furnace, and when cool is mixed thoroughly with a flux composed of, glass, 26 per cent; crushed coal, 18 per cent; salt, 13 per cent; fine iron scrap 43 per cent. Mix the flux with an equal weight of the grid filling, then melt at a temperature between 1000 and 1500 degrees Fahr. A blast furnace is best for smelting the lead residues, although a reverberatory also could be used. The flux and oxides and sulphates of lead must be intimately mixed.

Controlling Steel Composition

Operating Schedule for Acid Electric Furnace Is Suggested and the Elements Entering into the Process Are Discussed—Accurate Control of Product Depends on Duplication of Melting Conditions

BY A. C. JONES

ACCURACY of analysis control has been attained by some melters, but the majority are not maintaining consistently uniform accuracy. Melters will agree that reasonable consistency should allow a leeway of five points over or under the desired content. Perhaps some would feel that on carbon control the range should not extend over three points in either direction. With such a standard set for silicon, manganese and carbon, the carbon would show less deviation from the desired analysis. Fortunately carbon can be controlled better than silicon or manganese, but even the off-silicons and off-manganeses sometimes are expensive and a closer control is desired.

Although much depends on the close observation of the heat all the way through from start to finish, there are certain suggestions which can be worked up into a schedule of operation. First, however, some general remarks are in order.

In making steel many foundrymen change the melting practice too often. When trouble occurs with the castings which may or may not be due to the metal, a change is thought necessary which possibly means a more expensive practice. Then when everything goes smoothly as far as the quality of metal and even operation are concerned, an effort is made to cut down on the expense in some way. This brings further changes which sometimes are converted into more trouble. A change in practice should not be made once this phase has been carefully and thoughtfully adopted unless there is a strong reason for it.

After fairly good results have been obtained for a long period, a review of the original schedule will show that many minor points which affect the analysis and cost of the steel have been neglected. Then we start over again to be careful. Although it is necessary for the melter to depart from a possible schedule of additions sometimes, if the conditions are made as uniform as possible there should not be need for it often.

The first heat from a cold furnace often is harder to bring to the desired analysis than the following ones. If the interval between this and the former heat is not over 3 hours, charging the furnace directly after pouring the last heat would not affect the working of it. If the interval is greater, charging immediately before the power goes on is better, unless the atmosphere of the furnace can be made non-oxidizing immediately and the furnace sealed tightly. This is difficult to accomplish. Charging in advance causes considerable oxidation, particularly with material such as turnings, flashings and stock having large surface area. The result is that by the time the power goes on there is a heavy scale on all parts of the charge. This gives a thin slag, the bath melting down low in silicon, manganese and carbon. The situation is detrimental to the roof and lining, particularly with furnaces of heavy power input where the violence of the arc causes considerable splashing of this thin slag against those parts of the furnace. If some of the heavier stock is charged first and the turnings, etc., added just before starting the heat, this may be compensated.

Power Should Remain On

Once the power is on, it should not be taken off until the charge is in a molten condition unless absolutely necessary. If there is any work to be done such as changing electrodes, it should be taken care of before starting unless only a minute or two will be used. When parts of the charge are heated to a temperature ranging from 1500 degrees Fahr. to the melting point, excessive oxidation or scaling takes place and the slag becomes rich in iron oxide. The condition is more aggravating where the furnace is not kept air-tight during the melt down.

The consensus of opinion is that the furnace should be kept well sealed. This means not only a saving in time and energy, but helps to give a uniform blanket of slag on the melt down of each heat, all other conditions being the same. This is more important on furnaces that melt slowly and where the volume of oxygen passing into the furnace is greater because of the longer melting time. Not only is there a benefit in time, energy and control, but there is an economy in electrode consumption due to oxidation.

Another factor in analysis control is the silicon, carbon and manganese content of the charge going into the furnace. Requirements for all furnaces have to be worked out at each plant. The writer has aimed to get sufficient silicon, manganese and carbon in the charge so when the heat is melted and fairly hot and the finishing of the heat is to start, the silicon will be about .07, manganese .09; and carbon about .13 per cent. If the nature of the charge has to be changed, and the silicon and carbon come higher on the charge average, a certain calculated amount of ore must be added. Melting down to the above analysis gives a thin slag that is not so oxidizing as to leave the bath highly saturated with oxide. The residual should be as low as 0.07 for silicon, 0.09 for manganese and 0.13 for carbon, because at this point the steel starts to hang on tenaciously to these elements. Therefore, if the proper mixture is used all of the heats will come close to the above analysis from which the step-up can be made with favorable duplication. If on the other hand a mixture higher in metalloid content is used, some heats on account of greater oxidation will get to this level while other heats being less oxidized will have a higher residual content and the final analysis will show high results. In other words, the idea is to melt down to a similar condition as is obtained in converter practice and then to step-up quickly to the desired analysis. We know that control of analysis is less difficult in converter practice than possibly in any other process except the crucible, particularly when the metal is blown down completely. If it happens to show a greater degree of oxidation than usual we can readily calculate that not more than a certain number of points will have to be added extra. The danger of a bath with lower analysis, say 0.03 silicon, 0.04 manganese and 0.7 carbon, is that an unknown amount of oxide is dissolved in the steel.

The writer has found that with the Moore-type electric furnace melting a 3½ ton heat in one hour and 20 minutes, the mixture analysis to give the above residual content is about 0.22 silicon, 0.63 manganese and 0.30 carbon, using 50 per cent shop scrap and about 30 per

From a paper presented at the Rochester, N. Y., meeting of the American Foundrymen's association, held June 5-9, 1922. The author is with the Electric Steel Co., Chicago.

cent turnings, the remainder being forgings and shearings. The manganese is not considered important as it depends much on the actions of its partners, silicon and carbon. If they are high the manganese will stay also.

Let us consider each element by itself and look for the causes of erratic analysis and determine how to deal with the conditions. In discussing these points the writer is adhering to the idea before mentioned of a rather low residual content when the finishing of the heat is started.

Causes of Low Silicon

A lower silicon than desired is due to an excessive amount of iron-oxide in melting down. An excess of iron-oxide may be due to too much oxygen over a short or long period entering into the melting chamber and attacking the steel during that time. This is aggravated if there is not sufficient silicon, manganese, and carbon in the charge to neutralize some of this oxidizing power. Scrap with excessive rust and having a large surface area exposed to whatever oxygen may be about will cause an increase in iron oxide. A low silicon and carbon content of the charge will cause a more oxidized bath and slag, all other conditions in the furnace being the same.

To prevent such a condition, the furnace should be kept as air-tight as possible even after all material is melted. The condition of the charge should be kept uniform both as to analysis and physical condition. If there is more rust and some of the material is lighter, the silicon content of the charge should be increased slightly. In the first heat out of a cold furnace a longer time usually is required for melting. This heat should have a higher silicon and carbon content than the others.

If after an attempt has been made to prevent it, a thin oxidizing slag persists, the best thing to do is to slag off some of it so that less than the usual amount remains on the surface of the bath. Then add three or four shovels of sand, preferably silica sand, spreading it well so that it will be incorporated evenly and quickly into the slag. More of these ingredients may be necessary, but observation of the slag will show this, it becoming a little viscous when sufficient has been added and the steel is fairly hot. After the slag has been prepared in this manner, the bath should be rabbled to bring the steel in the lower part of the bath in contact with the slag. This helps particularly in quick melting where often the surface steel is deoxidized properly while the bottom is full of oxide. Silicon pig then is added to raise the charge to the normal silicon content on the melt-down. The increase is perhaps 8 to 10 points, allowing some for loss.

The silica analysis of a proper finishing slag should be between 50 and 60 per cent. With a higher silica content the slag becomes too thick for satisfactory roof and lining life. A thin, watery, oxidizing slag will vary between 15 and 30 per cent silica content.

High silicon usually is due to either a higher melt-down than usual where the oxidation of the elements silicon, manganese and carbon was much less than normal, or to an excessive reduction of silicon in the slag by the aid of carbon.

The first condition will be noticed as temperature tests are taken; the metal will lay quiet. Adding a shovel or two of ore as soon as possible will help. A reduction in amount of silicon to be added also is advisable. The amount to cut down, depends on the melter's observation.

Reduction of silicon from silica has been a drawback in the operation of many electric furnaces. Where the carbon content of the steel is above 0.25 per cent, considerable reduction takes place as the temperature goes up. A charge high in carbon melting down to 0.25 per cent so a minimum of carbon has to be added will pick up a good bit of silicon if the slag is right. With the high temperature obtained under the three electrodes, the reduction is greatest in these regions.

However, if the bath is kept at the carbon content of the proposed melt-down analysis of 0.15 per cent, practically no reduction takes place. Then if the carbon is added 2 to 3 minutes before the power finally is taken off and this time that the power is on after the carbon addition is kept the same, one heat after another, the silicons will show a surprisingly small variation, where other conditions are constant.

At the plant with which the writer is identified, the present practice in adding carbon for a regular heat of 0.25 per cent carbon is to dip two of the electrodes into the steel just before adding the manganese. The power is on only for exactly 2 minutes, checked by a stop watch. The pick-up of silicon cannot vary much when this is done. The danger of high silicon from heats calculated to finish with carbon much higher than 0.25 per cent is negligible, as the increase is obtained by dipping the electrodes at the end of the melt, after the power is off, to obtain the extra carbon.

To obtain a deoxidized slag and keep the silicon, carbon and manganese stationary to the end of the heat about 25 pounds of pea-sized hard coal to a 3-ton heat have been used lately. This is being added about 20 minutes before the heat is finished and is spread over the slag as uniformly as possible. Chestnut-size coal was tried, but it seemed that some of the heavier pieces penetrated the steel to a certain extent, raising the carbon indefinitely. Using the pea-size has eliminated this irregularity. Some pick-up of silicon by the bath is noted but this will be the same on all heats if it is introduced at the right time. This amounts to about 5 points.

A greater loss of silicon, manganese and carbon in melting down is experienced with a furnace melting slow and using graphite electrodes, than the same furnace with greater transformer capacity and using carbon electrodes. The oxygen in the chamber is changed readily to carbon dioxide by the carbon electrodes leaving a more neutral atmosphere and, therefore, allowing less oxidation. However, graphite is not so easily attacked as the loss in pounds of electrode per ton indicates. Such opposite conditions may explain the varying amounts of silicon, manganese and carbon additions used in electric furnaces of different plants.

The steel seldom picks up carbon in the same sense that silicon is said to be gained. High carbon sometimes comes unexpectedly because of malfunctioning of the automatic control at the end of the heat. If an electrode breaks off and becomes partly submerged, the carbon rises rapidly. Watching the board is about the best precaution possible. The hazard of high carbon is greater with the use of amorphous carbon electrodes than with graphite ones. The rate of absorption by the steel from a broken electrode is more with carbon than with graphite.

To bring down the carbon in such cases, unless it is hopelessly high, it is advisable to keep the power on and add sand to the slag to make it more silicious. The carbon then reduces the silica of the slag and the bath therefore loses its carbon. It usually is advisable to rabble the bath well after the electrode has been taken out and a sample should be analyzed immediately for carbon. To facilitate the lowering of the carbon the bath should be rabbled a couple of times so as to bring the high carbon in contact with the silicious slag. The above procedure may mean higher silicon than usual, and a hotter metal than would be desired.

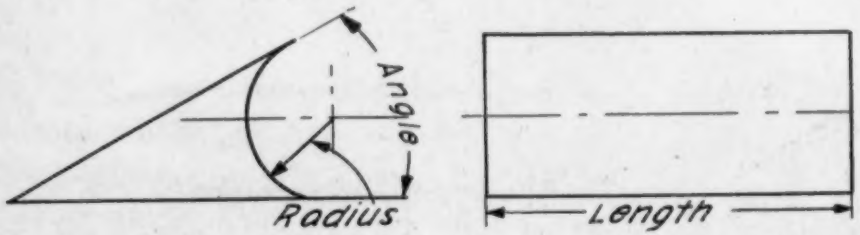
Carbon Content Causes Trouble

Some melters have considerable trouble in keeping their carbon up. On some heats they seem to lose more than on others. The ideal condition would be to incorporate the carbon as near as possible to the end of the heat. When adding pig iron, the power must be on a sufficient time to thoroughly dissolve the amount necessary, which on a 6000-pound heat with a residual of 0.12 to 0.15 would mean 175 pounds, not allowing any for loss.

Payment will be made for all contributions on foundry and pattern shop practice suitable for publication

WEIGHT OF CAST IRON FILLETS PER RUNNING INCH

By W. L. Tryon



The weights of cast iron fillets, 1 inch long are given in the accompanying table. To find the weight of a cast iron fillet of any length, multiply the weight per running inch obtained from the table below by the length.

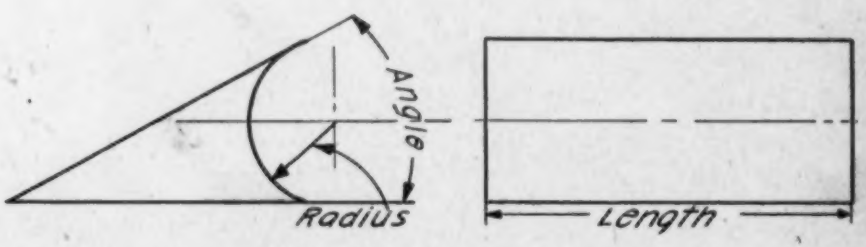
Weight of cast iron fillet 1 inch long when the angle is

Radius in inches	22½°	30°	45°	60°	75°	90°	105°	120°	135°	150°	165°
1/8	0.238	0.158	0.081	0.045	0.025	0.014	0.007	0.0035	0.0014	0.0004	0.0001
3/16	0.372	0.248	0.128	0.070	0.390	0.022	0.012	0.0055	0.0022	0.0006	0.0001
1/4	0.535	0.356	0.181	0.101	0.057	0.032	0.017	0.0079	0.0032	0.0009	0.0001
5/16	0.729	0.485	0.247	0.137	0.077	0.043	0.023	0.0108	0.0043	0.0012	0.0002
1	0.950	0.632	0.322	0.179	0.101	0.056	0.029	0.0140	0.0056	0.0016	0.0002
1¼	1.482	0.986	0.504	0.279	0.158	0.088	0.046	0.0219	0.0088	0.0025	0.0003
1½	2.14	1.424	0.725	0.402	0.227	0.126	0.066	0.0316	0.0126	0.0036	0.0004
1¾	2.92	1.94	0.990	0.548	0.309	0.172	0.091	0.0430	0.0172	0.0049	0.0006
2	3.80	2.53	1.29	0.715	0.404	0.224	0.118	0.0560	0.0224	0.0064	0.0008
2¼	4.82	3.21	1.63	0.905	0.511	0.284	0.149	0.0710	0.0284	0.0082	0.0010
2½	5.94	3.96	2.02	1.12	0.632	0.350	0.184	0.0877	0.0350	0.0101	0.0012
2¾	7.20	4.78	2.44	1.35	0.763	0.424	0.222	0.106	0.0424	0.0122	0.0015
3	8.55	5.70	2.90	1.61	0.908	0.504	0.264	0.126	0.0504	0.0145	0.0018
3¼	10.02	6.76	3.34	1.88	1.062	0.592	0.310	0.148	0.0592	0.0170	0.0021
3½	11.62	7.74	3.94	2.19	1.235	0.686	0.360	0.172	0.0686	0.0197	0.0024
3¾	13.39	8.86	4.53	2.51	1.419	0.786	0.413	0.197	0.0786	0.0226	0.0028
4	15.2	10.12	5.15	2.86	1.612	0.896	0.470	0.224	0.0896	0.0258	0.0031
4½	19.3	12.82	6.53	3.62	2.043	1.136	0.595	0.284	0.1136	0.0326	0.0040
5	23.8	15.8	8.05	4.46	2.52	1.40	0.735	0.350	0.140	0.0403	0.0049
5½	28.8	19.1	9.75	5.41	3.04	1.70	0.890	0.424	0.170	0.0487	0.0059
6	34.2	22.8	11.55	6.43	3.63	2.02	1.060	0.504	0.202	0.0580	0.0071
7	46.5	32.0	15.7	8.76	4.94	2.74	1.44	0.686	0.274	0.0789	0.0096
8	60.9	40.5	20.6	11.42	6.46	3.58	1.88	0.896	0.358	0.103	0.0126
9	77.0	51.3	26.0	14.48	8.16	4.54	2.38	1.135	0.454	0.130	0.0159

Note — This sheet may be cut into two sections, 5 x 7 inches, and may be readily bound in note book form.

WEIGHT OF CAST STEEL FILLETS PER RUNNING INCH

By W. L. Tryon



The weights of cast steel fillets, 1 inch long, are given in the accompanying table. To find the weight of a cast steel fillet of any length, multiply the weight per running inch obtained from the table below by the length.

Weight of cast steel fillet 1 inch long when the angle is

Radius in inches	22½°	30°	45°	60°	75°	90°	105°	120°	135°	150°	165°
1/8	0.252	0.172	0.088	0.049	0.028	0.015	0.008	0.0038	0.0015	0.0004	0.0001
3/16	0.392	0.268	0.137	0.076	0.043	0.024	0.012	0.0059	0.0024	0.0007	0.0001
1/4	0.565	0.386	0.197	0.109	0.062	0.034	0.018	0.0086	0.0034	0.0010	0.0001
5/16	0.770	0.526	0.268	0.149	0.084	0.047	0.024	0.0116	0.0047	0.0013	0.0002
1	1.003	0.686	0.350	0.194	0.109	0.061	0.032	0.0152	0.0061	0.0018	0.0002
1¼	1.57	1.072	0.548	0.304	0.171	0.095	0.050	0.0238	0.0095	0.0027	0.0003
1½	2.26	1.54	0.788	0.436	0.246	0.137	0.072	0.0342	0.0137	0.0039	0.0005
1¾	3.08	2.10	1.072	0.596	0.336	0.187	0.098	0.0467	0.0187	0.0054	0.0007
2	4.03	2.74	1.40	0.776	0.438	0.243	0.128	0.0608	0.0243	0.0070	0.0009
2¼	5.09	3.48	1.77	0.982	0.555	0.308	0.162	0.0770	0.0308	0.0088	0.0011
2½	6.29	4.29	2.19	1.21	0.684	0.380	0.199	0.0950	0.0380	0.0109	0.0013
2¾	7.60	5.19	2.65	1.47	0.825	0.460	0.242	0.115	0.0460	0.0132	0.0016
3	9.05	6.16	3.15	1.75	0.985	0.548	0.287	0.137	0.0548	0.0157	0.0019
3¼	10.62	7.22	3.69	2.05	1.154	0.643	0.337	0.160	0.0643	0.0185	0.0022
3½	12.32	8.39	4.29	2.38	1.38	0.745	0.392	0.186	0.0745	0.0214	0.0026
3¾	14.12	9.72	4.93	2.72	1.54	0.854	0.448	0.224	0.0854	0.0246	0.0030
4	16.1	10.98	5.60	3.10	1.75	0.973	0.511	0.244	0.0973	0.0280	0.0034
4½	20.4	13.9	7.10	3.93	2.22	1.23	0.647	0.308	0.123	0.0354	0.0043
5	25.2	17.2	8.75	4.85	2.74	1.54	0.798	0.380	0.154	0.0437	0.0053
5½	30.5	20.8	10.6	5.88	3.31	1.84	0.966	0.460	0.184	0.0530	0.0064
6	36.2	24.7	12.6	6.98	3.94	2.19	1.148	0.547	0.219	0.0628	0.0076
7	49.4	33.6	17.2	9.50	5.15	2.98	1.56	0.745	0.298	0.0856	0.01
8	64.4	43.9	22.4	12.4	7.00	3.89	2.04	0.976	0.389	0.1120	0.0136
9	81.4	55.5	28.4	15.7	8.88	4.93	2.58	1.232	0.493	0.1416	0.0172

Theoretically this would require about 2.9 per cent of the time of melting the heat or about 3 minutes. Then again the power would be on after the manganese had been added to the bath. Therefore, during this period there is a chance for quite a variation in loss, one heat from another. Dipping the electrodes in the bath has proved satisfactory. The following practice after determining the rate of carbon absorption by the bath from the electrodes has been found practicable. This was found satisfactory only with graphite electrodes, the rate of absorption being much more uniform than when using amorphous carbon electrodes. When the heat has reached the desired temperature, the power is turned off and two electrodes are immersed to a depth of 7 inches for 75 seconds which is the total elapsed time. With this regulation it takes 15 seconds for the electrodes to get down 7 inches and allowing 15 seconds for the upward trip, they remain stationary in the bath 45 seconds. This is slightly varied as indications warrant. Immediately the bath is rabbled well from both the spout and the door to mix the metal thoroughly. The power then is started and after 15 seconds the manganese added. At the end of 2 minutes the power is taken off. The bath again is rabbled well and heat is ready to pour. Should higher carbon steel be needed, the electrodes are again immersed at the end for as long as is necessary. Three electrodes should be used rather than hold any one over 100 seconds.

To realize the full benefits of the foregoing method, a fracture test should be examined just before adding the carbon to the steel. This may cause a decision to vary the length of time the electrodes are in the steel.

Manganese control should be easy if the carbon and silicon are uniform. The following are pertinent points in manganese control:

1. Lower carbon than usual means slightly lower residual manganese.
2. Lower silicon than usual results in lower residual manganese.
3. When small lumps of ferromanganese are prevented from reaching the bath by a viscous slag, lower manganese will result.
4. Variation of the time that power is on after adding the ferromanganese will give a corresponding variation in manganese content.
5. The volume and nature of the slag affects the control.

The first and second causes should be apparent to the melter by the time manganese is to be added, and therefore he can increase his additions slightly. The third cause is preventable, as sacks or containers can be obtained for pieces that might be trapped in the slag. Such containers serve their purpose well. The fourth factor, time, must be watched with consistent accuracy—even to seconds. Two minutes is ample time. Any longer period means the enriching of the blanket of slag with good manganese from the steel. This brings us to the fifth point. Too much slag means more manganese to satisfy the greater capacity for absorption. For this reason slagging off is desirable earlier in the heat where an extra heavy amount of slag is noticed.

The temperature of the steel has a slight bearing on the control of all three elements. Exceedingly hot steel loses carbon and manganese, the manganese going into the slag and also volatilizing.

Closer control of manganese can be obtained when adding all of the ferromanganese in the ladle, in small lumps, but the advisability of doing this is a matter on which there is a considerable difference of opinion.

Aspects of Control Problem

The sample for analysis is an important factor. It should be taken from a bar that will chill quickly in the sand, say 2 x 3 x 1 inches. The usual precautions for drilling samples should be kept in mind.

The test bar should be poured at the same time on each heat, preferably at the half-way mark. Tests made on samples after regular time intervals on the same heat have shown a consistent change in analysis. This was most pronounced with the element manganese, particularly when the heats were hot, the decrease being as much as 8 points from the first to the last metal on some unusually hot heats.

Accurate control of analysis depends on the duplication of proper conditions, heat after heat, and where there is a departure, it then is dependent on the ability of the melter to gage conditions and the approximate analysis of bath and slag and to bring the charge back to the desired content.

In studying the subject of analysis control, the idea of the practice conducive to steel of the highest quality has constantly been given prime importance. Adequate analysis does not always mean correct steel, but as a rule they are partners.

Prizes Awarded at Birmingham Show

One of the features of the recent exhibition and convention held in Birmingham, England, under the auspices of the Institution of British Foundrymen and the British Cast Iron Research association was a series of competitions covering coremaking, molding, and pattern making. Mainly these competitions were designed for apprentices in order to stimulate the training of skilled workmen.

The competitions were held under the direction of H. Lakin-Smith, vice president of the Birmingham chamber of commerce and chairman of the executive committee, assisted by J. E. Fletcher, director of research of the British Cast Iron Research association, who acted as chairman of the technical advisory committee, G. Henry Wright, and Thomas Vickers who was secretary of the technical advisory committee.

The first prize for light coremaking in Class A for young men under 21 years of age was awarded to G. Green, Smethwick, England, and the second prize to E. Ridgeway, Smethwick. The first prize in the medium cores went to J. Bishop, Birmingham, and the second prize to W. Glover, Willenhall. The first prize in the heavy core section was awarded to R. C. Clarke, Small Heath, and the second prize to W. G. Riley, Ladywood. The work of this section consisted of core molding including such tasks as radiator cores and steam port cores for cylinders.

In class B the first prize for floor molding went to J. Charley, Darlaston, the second prize to J. Scott, Sunderland, and the third prize to P. London, Bilston. In the two-part flask competition the first prize was awarded to J. Hartshorne, West Bromwich, the second prize to H. Millard, Cape Hill, and the third prize to W. Stevens, West Bromwich. In the three-part flask competition the first prize went to L. Ramsbottom, Darlaston, the second prize to A. McBride, Crewe, and the third prize to J. A. McIndoe, Aston. These prizes were donated respectively by Lord Weir, chairman, G. & J. Weir, Ltd.; the Worshipful Company of Founders; and The Institution of British Foundrymen.

In the pattern making competitions the first prize for competitors over 21 years of age was awarded to H. Sutcliffe, Halifax, the second prize to W. Jeans, Inverness, the third prize to C. J. Millard, Birmingham, and the fourth prize to G. Croft, Hexham-on-Tyne.

The first prize in pattern making for competitors under 21 years of age was won by H. Grayer, West Bromwich, the second prize by W. L. Leek, West Bromwich, and the third prize by J. Oddy, Smethwick. The latter prize of £2 2s was contributed by THE FOUNDRY.

The first and second pattern making prizes in the technical students' class were won by W. W. Graw, County Technical College, Wednesbury and G. J. Botfield, Handsworth Technical school, Birmingham, respectively.

Tentative Specifications for Cast Iron Wheels

I—Material

1—Wheels shall be made of a mixture of such composition that will produce the required chill in the tread and not show any mottled iron in the plates except around the chaplets where it shall not extend more than ½ in. (12.7 mm.). (The use of steel chaplets is preferred.)

II—Chemical Requirements

2—(*a*) The wheels shall conform to the following requirements as to chemical composition:

	Minimum	Maximum
Total carbon, per cent	3.25	....
Combined carbon, per cent	....	0.85
Silicon, per cent	0.45	0.75
Manganese, per cent	0.50	0.75
Phosphorus, per cent	....	0.40
Sulphur, per cent	....	0.18

(*b*) The minimum percentage of manganese shall be not less than three times the sulphur content.

3—Analysis shall be made by the manufacturer from test blocks poured during the day's melt from each cupola from which wheels purchased under these specifications are poured to determine the percentages of total carbon, manganese, phosphorus, sulphur and silicon. The chemical composition thus determined shall be reported to the purchaser or his representative upon request.

4—Drillings for check chemical analysis shall be taken from drill hole bored entirely through the back double plate of the wheel midway between the core leg holes.

III—Dimensions, Weight and Design of Wheels

5—Patterns and chillers shall be such that they will produce wheels according to the dimensions shown on drawings furnished by the purchaser.

6—The normal circumference conforming to the specified diameter shall be measured at a point $1\frac{13}{32}$ inches (43.65 mm.) from the gaging point on the throat of the flange. Wheels shall not vary more than $\frac{7}{16}$ inch (11.11 mm.) above or below normal size, measured on the circumference, but only $\frac{5}{16}$ inch (7.94 mm.) variation above or below normal size shall be allowed for any day's cast from one cupola.

The thickness of the flange shall be regulated by a maximum and minimum flange thickness gage which shall be not more than $\frac{1}{16}$ inch (1.59 mm.) over nor more than $\frac{1}{16}$ inch (1.59 mm.) under the normal flange.

7—All wheels shall be taped with a standard design of wheel circumference tape and have the numbers 1, 2, 3, 4, and 5 stamped ⅛ inch (3.18 mm.) apart, the figure "3" to represent normal tape size limited by $\frac{1}{16}$ inch (1.59 mm.) over or under the standard circumference, which for 33 inches (838.2 mm.) wheels will be 103.67 inches (2633.2 mm.). The figure "1" shall represent the smallest diameter, and the figure "5" the largest diametter. Tape sizes shall be stenciled in plain figures on the plate of the wheel or otherwise designated, as may be required by the purchaser.

8—(*a*) If wheels are ordered in accordance with A.R.A. standard drawings the weights shall be as follows:

Maximum Gross Weight of Car		Normal Weight of Wheel		Medium Weight of Wheel	
Lb.	Kg.	Lb.	Kg.	Lb.	Kg.
95,000	43,000	650	295	640	290
132,000	59,750	700	317	690	313
169,000	76,500	750	340	740	335
210,000	95,250	850	385	835	380

(*b*) In the case of wheels ordered with cores smaller in diameter than the standard, the additional weight shall be considered as additional to the normal weight given in the above table and be paid for by the purchaser.

(*c*) In any shipment where the average weight of wheels is above the normal weight given in the above table the excess weight shall be at the expense of the manufacturer.

IV—Inspection

9—Manufacturers shall notify the purchaser when ready to make shipment and shall furnish all necessary facilities and labor to enable the inspector to make test and prompt shipment of wheels.

10—The body of the wheel shall be free from slag, shrinkage, or blow holes. The tread and throat shall be free from irregular wrinkles, slag, sand wash, chill cracks or sweat. Wheels will not be rejected on account of cracks around the circumference of the center core commonly known as *drawn hubs* or slight shrinkage holes on the face of the hub which will not interfere with the proper mounting of the wheels.

11—All wheels shall be marked and numbered consecutively in accordance with instructions issued by the purchaser. All wheels shall have the initials of the purchaser, wheel number, weight of wheel, month, day and year when made plainly cast on the inside plate of the wheel. No wheels shall have duplicate numbers and all indistinct or duplicate numbers may be corrected only after having received the approval of the inspector. All wheels shall have the name of the manufacturer and place of manufacture cast on the outside plate of the wheel.

12—When ready for inspection, the wheels shall be arranged in groups, all wheels of the same date being grouped together, and for each 102 wheels which pass inspection and are ready for shipment, two representative wheels shall be taken, one of which shall be subjected to the thermal test and the other shall be used for the drop test.

13—(*a*) In making the thermal test the wheels shall be laid with the flange downward in the sand and a channel-way 1¾-inch (44 mm.) in width at the center of the tread for all wheels up to and including 700 pounds in weight and 2 inches (51 mm.) in width at the center of the tread for all wheels over 700 pounds in weight and 4 inches (102 mm.) deep shall be molded in green sand around the wheel, the tread of the wheel to form one side of the channel-way and the clean flange forming as much of the bottom as its width will cover. This channel-way shall be filled with molten cast iron which shall be hot enough when poured, so that the ring cast, when the metal is cold, will be solid and free from wrinkles. The time when pouring ceases shall be noted and after two minutes has elapsed an examination of the wheel shall be made. If any cracks develop in any part of the wheel, all wheels bearing the same tape size as represented by the sample shall be rejected.

(*b*) In order to prevent spitting while pouring, the tread and flange may be covered with a coat of shellac. Wheels selected for test which are wet or which have been exposed to snow or frost may be warmed sufficiently to dry them or remove the frost before testing, but under no circumstances shall the thermal test be applied to a wheel that in any part feels warm to the hand.

14—(*a*) The anvil of the drop testing machine shall be supported on rubble masonry or a concrete foundation at least 2 feet (610 mm.) deep and shall weigh

(Continued on Page 643)

Modify Wheel Specifications

A. S. T. M. Makes Changes in Its Specifications for Chilled Cast-Iron Wheels and Retains Them as Tentative for Another Year—Recommendations for Low Phosphorus Withdrawn

SPECIFICATIONS for chilled cast-iron wheels adopted as tentative last year by the American Society for Testing Materials were retained as tentative again at the recent meeting in Atlantic City in June instead of being adopted as standard. They will again come before the society next year with any modifications the committee may recommend. In the meantime suggestions will be received by the committee from persons desiring modifications. Several such modifications were made in them this year. The section which stated that it is desirable that the phosphorus content shall not exceed 0.30 per cent was omitted as to large number of tests made indicated that no benefit was to be obtained by keeping the phosphorus content below 0.40 per cent. The weight of the tup used in the drop test was increased to 250 pounds, but this increase is thought by many engineers to be too low and after more data are secured this may be increased to an amount indicated as more practical.

Tentative Specifications for Cast Iron Wheels

(Continued from Page 642)

not less than 1700 pounds (770 kg.). The striking face of the tup shall be 9 inches (229 mm.) in diameter and flat. The face of each of the three bosses supporting the wheel under test shall be flat and measure 5 inches (127 mm.) in width.

(*b*) The test wheel shall be so placed on the three supports with the flange down, that the tup will strike centrally on the hub. The test wheel shall pass the requirements given in Table I without breaking in two or more pieces. If the test wheel fails, all wheels bearing the same tape size shall be rejected.

Table I

Weight of Wheel		Weight of Tup		Height of Drop		Number of
Lb.	Kg.	Lb.	Kg.	Ft.	M.	Blows
650	295	250	113	9	2.75	12
700	317	250	113	10½	3.20	12
750	340	250	113	12	3.65	12
850	385	250	113	15	4.60	12

(*c*) If the test wheel cracks before the twelfth blow it shall be required to stand 15 blows before breaking in two or more pieces.

15—The wheel selected for the drop and thermal test shall, following such test, be broken so that the chill may be examined at least four different portions of the wheel. The depth of pure white iron shall conform to the following requirements:

Weight of Wheel		Maximum Depth—At Middle of Thread		Maximum Depth—At Throat		Minimum Depth—At Middle of Thread		Minimum Depth—At Throat	
Lb.	Kg.	In.	Mm.	In.	Mm.	In.	Mm.	In.	Mm.
650	295	1	25.4	7/8	22.2	1/2	12.7	3/8	9.5
700	317	1 1/16	27	7/8	22.2	1/2	12.7	7/16	11.1
750	340	1 1/8	28.6	7/8	22.2	1/2	12.7	1/2	12.7
850	385	1 1/8	28.6	7/8	22.2	1/2	12.7	1/2	12.7

The depth of the chill shall not vary more than ¼ inch (6.35 mm.) in the middle of the tread on the different portions measured. If the sample does not conform to the requirements stated, all wheels of the tape size represented by the sample shall be rejected.

Note: The chill and physical tests specified only cover 33-inch wheels of the weights listed; other diameters and weights shall be in proportion.

V—Retest

16—Should the test wheel selected for the drop test, thermal test, or chill test fail to meet the requirements specified, all wheels bearing the same tape size shall be rejected (Sections 13, 14 and 15). The inspector shall then select another wheel of a different tape size, which shall be submitted to the same test as the wheel which failed and if it passes the requirements of the test the remainder of the lot shall be accepted, provided the requirements of all other tests have been met.

VI—Rejection

17 The numbers of all wheels which have been rejected because of failure to meet the requirements of the drop test, thermal test, or chill test shall be noted and such wheels shall not be submitted for test at any future time.

18—Individual wheels shall be rejected if they are:

(*a*) Under the minimum weight specified;

(*b*) Have surface defects mentioned in section 10;

(*c*) Over or under the specified dimensions.

As information of possible value to the users of these specifications, Committee A-3 on Cast Iron wishes to state that the Association of Manufacturers of Chilled Car Wheels have adopted recommended designs of cast-iron car wheels of 24, 26, 28, 30, 33, 36, 39 and 42-inch diameter. The designs for the 33-inch diameter wheels have been approved by the American Railway association. The wheels for which designs have been made, the standard for maximum load and estimated weight of the wheels are given below:

Diameter of Wheels Inch	Standard for Maximum Load per Wheel, Pounds	Estimated Weight, Pounds
24	6,000	320
24	9,000	360
24	12,000	400
24	16,000	440
26	6,000	360
26	9,000	410
26	12,000	460
26	16,000	510
28	6,000	410
28	9,000	460
28	12,000	510
28	16,000	560
30	6,000	485
30	9,000	530
30	12,000	575
30	16,000	615
33	11,875	650
33	16,500	700
33	21,125	750
33	26,250	850
36	12,000	740
36	16,000	800
36	20,000	860
36	25,000	980
39	16,000	875
39	20,000	950
39	25,000	1100
42	16,000	1000
42	20,000	1075
42	25,000	1225

Model Foundry at the Birmingham Show

One of the features of the recent International Foundry Trades exhibition in Birmingham, England, which was held June 15-24 under the auspices of the British Cast Iron Research association and the Institution of British Foundrymen, was a model foundry completely equipped for work. An entire bay in Bingley hall was set aside for this purpose, the general arrangement of the model foundry being shown in the accompanying illustration. Various manufacturers contributed items of equipment which included everything necessary for the production of gray iron castings. Although no iron was melted during the exhibition, the model foundry was put to practical use in connection with the molding and core making competitions which were held in conjunction with the Birmingham show.

Issues Complete Catalog of Equipment

J. W. Jackman & Co., Ltd., London and Manchester have issued a 300 page, cloth-bound catalogue of foundry equipment and machinery. The book is divided into 11 sections covering requisites and sundries, melting equipment, metal recovery machinery, sand preparing equipment, molding machines and appliances, core shop equipment, cleaning and dressing shop equipment, air compressors and receivers, transportation equipment, testing machines and laboratory equipment, and useful tables for foundrymen.

The first section, requisites and sundries includes metal fluxes, furnace tools, refractory materials, blackings and facings, parting powders, core binders, molder's and coremakers,' patternmakers' and cleaning room sundries, requisites and safety appliances. Under melting equipment various types of cupolas, spark arresters and cupola fans are given, together with descriptions and photographs of cupola platform hoist, blast gate, pressure gage, pig iron breaker, ladles of various kinds and coal breakers. The section on metal recovery takes in cinder mills, electro-magnetic separaters, and magnetic pulleys. Sand preparing equipment described, with illustrations, includes several types of sand mills, sand screens and mixers, sand disintegrators, sand sifters and riddles. Over 40 different types of molding machines together with sand rammers, vibrators, suction oilers, blowing nozzles, air couplings, pattern plate, and mold dryers are covered in the portion devoted to this subject. Core shop equipment including the various types of core machines, cutting-off and tapering machines, jolters, core trays, core ovens, oven trucks, rope spinning machines, wire straighteners and cutters are minutely described; while cleaning equipment noted includes sand-blast cleaning rooms, sand-blast trucks, helmets, sand-blast machines, chipping tables, dust collectors, tumbling barrels etc.

Handling equipment presented represents the best of European practice such as several types of air hoists, trolleys, hangars, turntables, and sling beams. Testing machines and laboratory equipment shown includes contraction and chill apparatus, machines for testing hardness of metal, altometers, dividing machines, apparatus for folding tests, fatigue testing machines, etc.

MODEL FOUNDRY INCLUDED IN EXHIBITS AT THE BIRMINGHAM SHOW

Submit Invoice Standard

The attached illustration shows the seventh tentative form of the national standard invoice. This was developed by the four committees named on its face at a conference held in Philadelphia April 14th.

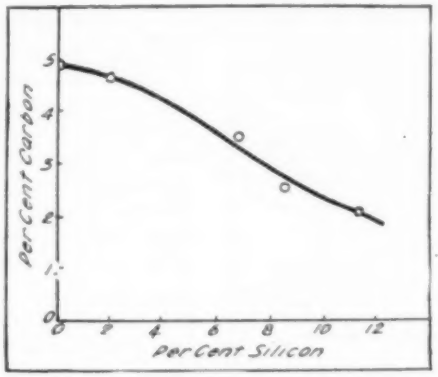
During the summer the form will be submitted to the conventions of the four associations for ratification. It embodies all of the practical suggestions which have been received from those using the present form during the year and a half it has been in force. These modifications, while not great, eliminate the little difficulties which were met, and the form now is not apt to be changed for a number of years.

The form which is now in use by a number of corporations was adopted by the National Association of Purchasing Agents at their convention in Chicago in 1920. It was afterwards endorsed by the National Association of Cost Accountants, as well as a number of railroads and other corporations. This form resulted from two public conferences, held a year apart in Philadelphia and Chicago, and represented what was then thought to be the most practical arrangement. Now that it has been in use for more than a year by a number of corporations certain constructive criticisms developed and were considered at the third public conference.

Supplies Additional Data on Carburization

To the EDITOR—In reference to the article "Carburize Synthetic Cast Iron" appearing in th May 15th issue of THE FOUNDRY, the following additional discussion, made on the basis of experiments that were performed after the original article was prepared, may be of interest:

Although silicon does not affect the rate of carburization of iron, it does affect the maximum possible absorption of carbon. The accompanying figure shows the relation between silicon and carbon, the points on the curve representing the maximum carbon content of samples of iron containing various amounts of silicon, at 1450 degrees Cent. These values were obtained from samples taken from a bath of metal held at this temperature, in contact with carbon, until its carbon content remained unchanged for one hour. The samples were chilled to prevent any reduction of the carbon content by the ejection of kish during cooling. It may be seen from the accompanying curve that an increasing content of silicon decreases the maximum absorption of carbon obtainable but that even with 5 per cent silicon it still is possible to have 4 per cent of carbon, and, therefore, the practical effect in ordinary cases should not be strongly marked.



EFFECT OF SILICON ON SOLUBILITY OF CARBON IN IRON

CLYDE E. WILLIAMS and C. E. SIMS
United States Bureau of Mines
Seattle, Wash.

Main offices and sales room of the Barnes Foundry Co., Inc., have been moved from 169 Second street, Jersey City, N. J., to 515 West Fifty-sixth street, New York. The foundry and machine shop have been moved to Freeland, Pa.

Customer { Ord. No. & Date / Requisition No. / Contract No.
Shipped to
Destination

Invoice date
Invoice No.
Shipper's Order No.

This column reserved for use of customer.
P. A. Invoice No.
Voucher No.
CHECKED { With order / F. O. B. point / Price / Calculations / Transportation / Trans. Chgd. back

Terms:

To be written or printed here.

Name and address of customer to whom invoice is to be mailed may be put in this space.

Date Shipped
Car No. and Int.
How Shipped and Route

From

F. O. B.

DESCRIPTION	QUANTITY (SHOW UNIT)	PRICE PER UNIT	AMOUNT

Committees from the following organizations have co-operated in the development of this form.

The National Association of Purchasing Agents.
Disbursement Committee of Railway Accounting Officers Association.
National Association of Cost Accountants.
Div. VI Purchases and Stores of the American Railway Association.

Line spacing may be suited to machine or hand writing maintaining same relative positions. Sheet 8 1-2 inches wide and not less than 7 nor more than 14 inches long.

Four top lines to be replaced by shipper's name and address. Form may be moved down if more space is needed for shipper's name. A tolerance of 1-8 inch in either dimension is contemplated. Invoices longer than 7 inches to have dots or short rules printed on sides 7 inches from top to indicate point of fold for filing.

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Higher Prices for Quality in Sand

COMMON interest exists between the foundryman and the sand producer in raising the standard of the sand delivered to the molding floor. The time is opportune to emphasize this point. Seldom has so much interest been shown in any foundry subject as was evidenced in the molding sand sessions during the American Foundrymen's Association convention at Rochester. The castings manufacturer is awakening to the vital importance of quality in the molding sand he is using. He is beginning to appreciate the financial loss which is incurred by defective castings due to poor facing sand. Especially is this true in the steel casting industry. Now that the producer of castings is fully awake to the importance of securing a high quality of molding sand, the producers of such grades should help to emphasize the necessity of high class sand and give the foundryman to understand the difference between a graded and uniform sand and one taken promiscuously from the bank and delivered to the consumer. It will not take the foundry executive long to realize that sand cannot be prepared properly and uniformity secured at the banks without expenditure of money, and he gladly will pay the extra cost if insured that the produce he is getting is superior for his purposes. However, he must have means to determine quality and this cannot be done without recognized standard tests which must be more generally adopted. The producer of the high grade sands would be greatly benefited by the adoption of such tests and should support them. Of course, at times disputes may arise and a shipment not up to standard may be rejected or a rebate asked, but this should be compensated by a higher price for guaranteed satisfactory material. Whatever may be said by the salesman about the purchasing agent giving the business to the lowest bidder regardless of quality, it must be remembered that he primarily has the interest of his firm to guard, and if better sand means lower production cost the purchasing agent will pay a higher price for a better product. Often the salesman has trouble in convincing the purchasing agent that a higher price should be paid for the article he is offering than for the product of his competitor because he cannot prove conclusively that he has a superior ware although he may believe it and proclaim it long. What the purchasing agent wants before he will authorize the payment of a higher price is definite and specific proof, not only of quality, but that the extra quality will mean a saving of manufacturing expense or an enhancement of the value of the manufactured article. Thus the field is clear for the producer of molding sand to convince, first the production executive and through him the purchasing agent, that quality in sand means a cheaper casting, and that quality is synonymous with his product. Then he will have little difficulty in securing a price which will amply pay him for inspection and grading of his sand at the bank, and the local producer who opens up a small bank securing a little good sand at one time and a far different grade as he goes deeper into the bank will be unable to sell all of his product on the same basis to the detriment of good castings and the industry as a whole.

Trade Outlook in the Foundry Industry

WHILE a few foundries at present are confronted by an immediate shut down, due to the shortage of fuel or metal brought about through the rail and mine strikes, the period is not far distant when this situation must be faced. True, stocks of pig iron and coke alike have been adequate, except in a few localities; but shipping difficulties have increased, the production and shipment of foundry materials have slackened and finally the priority ruling of the interstate commerce commission has set up a barrier which eventually will hamper foundry operation.

Metals Not Favored

Under the priority ruling, coal will be handled by railroads east of the Mississippi under five classifications, starting with special favored divisions to be named later, fuel for railroads and ships, public utilities, for lake transportation to the northwest, for domestic use and finally for all other purposes. Fuel for the castings industry will fall within the fifth classification, and with the steadily dwindling production and transportation of both fuel and metals, the end is obvious. Up to the middle of July, little embarassment was experienced by foundries. Stocks of coke and iron were adequate both for jobbing and specialty gray iron shops. With the slack requirements of heavy castings plants, such as those devoted to the machine tool industry, the tonnage melt has not been of such proportion as to threaten seriously the available supply of pig iron. Increased output of castings just has begun to affect the supply of iron in storage at the close of July by heavier demands upon yard stock piles.

Prices of Raw Material for Foundry Use

CORRECTED TO JULY 27

Iron		Scrap	
No. 2 Foundry, Valley	$25.00	Heavy melting steel Valley	$16.75 to 17.00
No. 2 Southern, Birmingham	18.50 to 20.00	Heavy melting steel, Pitts.	16.50 to 17.00
No. 2 Foundry, Chicago	25.00 to 26.00	Heavy melting steel, Chicago	15.50 to 16.00
No. 2 Foundry, Philadelphia	27.64 to 29.13	Stove plate, Chicago	16.50 to 17.00
No. 2 Foundry, Buffalo	26.00 to 27.00	No. 1 cast, Chicago	18.00 to 18.50
Basic, Valley	25.00	No. 1 cast, Philadelphia	18.00 to 20.00
Basic, Buffalo	26.00	No. 1 cast, Birmingham	15.00 to 15.50
Malleable, Chicago	24.00 to 25.00	No. 1 cast, Buffalo	18.50 to 19.50
Malleable, Buffalo	26.00 to 27.00	Car wheels, iron, Pittsburgh	18.50 to 19.00
Coke		Car wheels, iron, Chicago	19.00 to 19.50
Connellsville foundry, coke	$14.50 to 15.00	Railroad malleable, Chicago	17.50 to 18.00
Wise county foundry, coke	9.50 to 10.50	Agricultural mal., Chicago	17.50 to 18.00
		Railroad malleable, Buffalo	17.00 to 17.50

Fuel Grows Scarce

Coke supplies have been harder to obtain. In Cincinnati fully half of the foundries were closed at one time due to nondelivery of coke. Slow transportation has proved even a greater obstacle than manufacturing difficulties, in securing fuel supplies. Car congestion and shortages in the non-union fields, coupled with delays incident to bad order motive power and crowded freight yards all have contributed to the difficulty. With the increasing scarcity of coke, higher prices are noted in some sections. However, many of the producers are caring for old customers with but little advance over the prices governing during the past months. Some competition is evident from other industries. A case in point is a large chemical company which uses coal ordinarily for its furnaces, but which recently has been crowding into the coke market to fill its extensive requirements. Pig iron producers have been strongly affected, over 15 blast furnaces having been banked or blown out up to the week of July 24; while the priority ruling will result in further curtailment. Changes are noted in the character of output from blast furnaces, those grades of iron being produced which require the least fuel.

Demand Continues

With but few exceptions, the demand for castings has continued and increased. Automotives have furnished steady requirements, throughout the month of July, although it is stated that the total production for that month will drop below the record output of 261,963 cars manufactured in June. A decline in automobile sales is noted, but up to the end of the month, no slackening is apparent in demand for all classes of automotive castings. Railway buying still continues strong and foundries handling railway specialties are operating at capacity. Malleable foundries, particularly in the eastern states are hampered by a shortage of labor. Some shops are operating at 50 to 65 per cent of capacity, when the orders on hand would justify full schedules, were men available. The same conditions are noted in stove shops in the central western states. An Ohio stove foundry advertised in 10 daily papers in various centers for stove work molders, but did not succeed in securing sufficient men to start its second plant which had been idle for several months. Cast iron pipe foundries are purchasing iron in large quantites, while fittings and specialty shops are working at capacity. A better outlook exists for farm implement manufacturers than at any time in the past two years. Commodity prices are slightly better and as a consequence more farm machinery is being sold. One western firm reports that May and June sales showed an advance of 53 per cent over the same months of 1921. June sales of this firm were 50 per cent greater than for any similar period in the past 14 months. Building construction continues with increased activity, with a direct and beneficial effect upon a great number of castings plants. Plumbers goods particularly are in demand. The unprecedented sale of sanitary ware continues and the faith of the manufacturer of this class of work in continued prosperity is evidenced in the unusually large tonnages of iron placed by them within the past few weeks. General jobbing lines are active, while pump works, light engine manufacturers and makers of oil field sundries are experiencing a demand which has grown steadily since the first of the year.

Nonferrous Prices

Prices for nonferrous metals based on New York qoutations in *The Daily Metal Trade* of July 27, follow: Casting copper, 13.37½c to 13.50c; electrolytic copper, 14.00c; Straits tin, 32.87½c; antimony, 5.25c; lead, 5.75c; aluminum, No. 12 alloy, producers' price, 19.00c to 19.20c; and open market, 16.00c to 16.50c. Zinc is 6.05c to 6.10c, E. St. Louis, Ill.

Comings and Goings of Foundrymen

WILLIAM J. GRUSS, who has been head of the pig iron sales department of Pickands, Mather & Co., Cleveland, since 1913 has resigned effective July 10. He will become manager of sales of the Gartland-Haswell-Rentschler interests, with headquarters at Dayton, O., and will take up his duties there Aug. 1. Mr. Gruss has been with Pickands, Mather & Co. for more than 28 years working up by gradual stages to his important executive position. He was born in Salem, O., April 10, 1878. He is widely known among pig iron manufacturers and has an extensive acquaintanceship in the foundry trade, bringing to his new position a broad knowledge of its requirements. He is a member of the American Iron and Steel institute and also of the Union club, Athletic club and Chamber of Commerce of Cleveland. He will be succeeded by George W. Striebing, who has been with the company for 11 years in the pig iron sales and ore sales departments.

Clifford Thompson, Springfield, Mass., mechanical engineer, has accepted a position with the Grafton Foundry Co., Grafton, Wis.

Sam F. Long, 1730 North Cleveland street, Canton, O., recently was appointed sales representative for the National Roll & Foundry Co., Avonmore, Pa.

John H. Eastham, recently superintendent of the Salem Iron Foundry Co., Salem, Mass., has assumed a similar position with the Sidney C. McLouth Foundry, Marine City, Mich.

G. Harold Gilpatric, secretary and treasurer of the Putnam Foundry & Machine Co., Putnam, Conn., is a candidate for a third term as treasurer of the state of Connecticut.

Jack Misch, formerly foundry foreman for Maxwell, Manning & Moore Co., Muskegon, Mich., has been appointed foundry superintendent to succeed E. S. Armstrong, resigned.

Frank H. Reynolds has resigned his position as vice president and general manager of the Crawford & McCrimmon Co., Brazil, Ind., manufacturers of hoisting and hauling engines, pumps and jobbing castings.

D. R. Curtenius has assumed control of the Goodale Co., Kalamazoo, Mich., having resigned as general manager of the Kalamazoo Stove Co., with which concern he had been connected since his boyhood. A. L. Blakeslee succeeds Mr. Curtenius as general manager of the Kalamazoo Stove Co.

John F. Kalk, formerly with Dunham Co., Berea, O., and for the last three years superintendent Muskegon Castings Co., Muskegon, Mich., has

WILLIAM J. GRUSS

been appointed superintendent of the Eagle Foundry Co., Muskegon, Mich.

Thomas Stewart, until recently with Inter-State Foundry Co., Cleveland, O., has been made superintendent Muskegon Castings Co., Muskegon, Mich., succeeding John F. Kalk, resigned.

F. G. Peterson, for five years manager of the foundries of the Bucyrus Co., South Milwaukee, Wis., has been made manager of the Hercules Steel Castings Co., Milwaukee. Frank E. McIntyre, formerly manager of the Hercules company, is with the National Steel Foundries division of the National Brake & Electric Co., Milwaukee.

H. D. Keller, well known foundryman and furnace maker, formerly with Ideal Furnace Co., Milan, Mich., and later with Homer Furnace Co., Coldwater, Mich., is president of the recently organized Keller Heating Co., Oldsmar, Florida, which took over the foundry and shops of the Oldmar Tractor Co. A foundry operating thirty molders, the largest in Florida, is devoted to the production of orchard heaters.

Edward Peterson has been named chief engineer of the Birdsboro Steel Foundry & Machine Co., Birdsboro, Pa. He formerly was assistant chief engineer of the Treadwell Engineering Co., Easton, Pa., and previous to that was assistant to the chief engineer of the American Steel & Wire Co., Pittsburgh.

William E. Hoblitzelle has resigned as first vice president of the Duquesne Steel Foundry Co., Pittsburgh to become president of the Smith & Davis Mfg. Co., St. Louis, manufacturer of beds, hospital furniture, etc. Mr. Hoblitzelle was born in St. Louis in 1871 and there received his education. His first position was that of shipping clerk at the Bessemer, Ala., plant of the Shicklè Harrison & Howard Iron Co., St. Louis. In 1899 he was removed to the St. Louis plant as cost accountant, remaining until it was absorbed by the American Steel Foundries in 1901 or 1902, at which time he became assistant to the general manager of the American Steel Foundries. He discharged these duties until 1904 when he was appointed general manager of the Commonwealth Steel Co., St. Louis, remaining in that capacity until 1916. Following a sojourn in California, Mr. Hoblitzelle came to Pittsburgh shortly after the outbreak of the war to assume the management of the Duquesne Steel Foundry Co., the president and general manager having entered the service.

Remove Chicago Offices

The Mesta Machine Co., Pittsburgh, has removed its Chicago office from the McCormick building to the Peoples Gas building. C. J. Mesta, second vice president of the company, who has been in charge of the Chicago office for over a year, has returned to the home office in Pittsburgh to take charge of the sales department of the company. A. B. Neumann, mechanical engineer, has been appointed manager of the Chicago office. Mr. Neumann has been in the Chicago district for a number of years as chief engineer and consulting engineer for several of the steel plants in that district.

Prominent Roll Foundries Are Merged

Representative roll foundries have merged in the Pittsburgh district under the name of the Mackintosh-Hemphill Co., formerly Mackintosh, Hemphill & Co. The new company acquires the plants, including fixed assets, good will and business of the Pittsburgh Iron & Steel Foundries Co. and the A. Garrison Foundry Co. Mackintosh, Hemphill & Co. was incorporated in 1893 under the laws of Pennsylvania to manufacture iron and steel mill equipment, alloy and steel rolls and castings. It succeeded to a business which had been in continuous operation for about 100 years, having been founded about 1825 by Alexander McClurg as the Fort Pitt Foundry. The consolidated companies will have an annual capacity of approximately 65,000 tons of iron, steel and alloy castings and will be equipped for the manufacture of iron, steel, copper, brass and tube mill machinery and equipment, alloy steel, chilled and sand iron rolls, miscellaneous machinery and equipment. The properties had a ready market value of in excess of $2,000,000 and the approised value of the plants is in excess of $7,250,000, comprised as follows: Mackintosh-Hemphill Co. plant, approximately 3½ acres at Twelfth street, Pittsburgh; Pittsburgh Iron & Steel Foundries Co. plant, over 20 acres at Midland, Beaver County, Pa.; A. Garrison Foundry Co. plant, about 3¾ acres at South Tenth street, Pittsburgh. To provide for future development, as the needs of the business require, the Mackintosh-Hemphill Co. owns a 45-acre tract of vacant land, well suited for manufacturing purposes, near Aspinwall, Allegheny county, Pa., fronting on the Allegheny river.

Obituary

William H. Holland, prominent industrial leader and manufacturer died suddenly Wednesday, June 14, at his home at South Bend, Ind., at the age of 56. Mr. Holland had just returned from Chicago where he had been under the care of specialists having been ill for over two years, when he died from a cerebral hemorrhage. Mr. Holland was actively engaged in his various business interests up until the time of his death. He was identified with many prominent manufacturing plants of South Bend and northern Indiana, being president of the Motor Castings Co., vice president of the South Bend Bait Co., president of the Elkhart Iron Works, president of the Clover Leaf Mfg. Co., director of the American Earth Works beside the Sibley Machine Co., which was his most active interest and the Citizens National bank of which he was president. He was also prominent in club and lodge activities. Born in Florence, Neb., in 1866, Mr. Holland removed to South Bend at the age of 5. He started to work for the Sibley & Ware Mfg. Co. at fifty cents a week when he was 14 years old. He rose rapidly in the business and some years later became president.

Bill's Vacation

STARTING in February, 1919 and continuing practically without interruption since, Bill, through his favored chronicler, Pat Dwyer, has added his bit to the store of foundry knowledge in an entertaining fashion. He now is taking a well earned vacation, and accordingly his reminiscences are omitted from this number. They will be resumed in an early issue.

Patrick Doyle, late treasurer the Worcester Brass Co., Worcester, Mass., died recently. The business will be continued under the same name by James P. Doyle, president and treasurer and Wm. T. Doyle, clerk.

Fred Kruecke, 52 years old, superintendent of the Kruecke Brothers Manufacturing Co., 515 Park street, Milwaukee was found dead from natural causes in a room he occupied two doors from the Kruecke foundry on the morning of June 26.

Adopt Safety Code for Foundries

Adequate provision for the protection of industrial workers in foundries in the iron, steel, tin, zinc, lead, aluminum and other industries is covered in the National Safety code for the protection of industrial workers in foundries, which has been approved by the American Engineering Standards committee. This is a revision of the code developed by the American Foundrymen's association and the National Founders' association, joint sponsers of the new work.

The approved code deals with foundry conditions only, omitting such subjects as building construction, lighting, sanitation, etc. as these are covered in other systems. It consists of 124 sections which are grouped under the following main divisions: Entrances, floors, pits and galleries, gangways, aisles, foundry equipment, finishing and cleaning, heating ventilation, operating rules, protection devices, employment of females, and recommendations.

Book Review

The Analysis of Non-Ferrous Alloys, by F. Ibbotson and L. Aitchison, 246 pages; 6 x 9 inches; cloth; published by Longmans, Green & Co., and for sale by THE FOUNDRY, Cleveland; price, $4 net.

The authors give methods for the analysis of nonferrous alloys which it is said are as rapid as is consistent with accuracy, and explain these methods with the theory so that the student may understand the reason for the different operations. Electrolytic methods being so important in this field, details of the apparatus used are shown by line drawings before the theory of electrolytic analysis is presented. Also, the theory of precipitation by hydrogen sulphide is fully explained, tables being given showing the solubility of the different sulphides in hydrochloric acid solutions at various temperatures.

Before methods are outlined for the analysis of the commercial alloys, each element is considered separately and procedure is outlined for determining them by the methods generally employed. Thus for most of them, electrolytic gravimetric and volumetric methods are included. With this full information on the behavior of the different elements, the methods for their separation in commercial alloys are more easily understood and the student becomes familiar with details which require watching.

Therefore, this book which contains methods of great value even to the experienced chemist is easily understandable by the younger student who will find it of value in his analytical work.

Purchases Stoker Firm

The Sanford-Riley Co., Worcester, Mass., stoker manufacturer and owner of the Murphy Iron Works, Detroit, recently has purchased the Underfeed Stoker Company of America, Kalamazoo, Mich. Stokers will be built and assembled at all plants, the castings for which will be made by the Murphy Iron Works plant.

Strikes Exert Slight Influence

Foundry Activity Continues and Supplies a Steady Demand for Foundry Equipment—New Projects are Under Way—Labor Shortage Anticipated Brings Sales of Cleaning Room Sundries

REFLECTING the minor influence of the rail and mine strikes upon the foundry industry, the demand for foundry equipment is but little affected. Brisk inquiry is noted for cleaning room equipment, interest is evidenced in heating units to convert core and annealing ovens in event of coal shortages, and fair sales of molding machinery are reported. Foreign demand also is noted. The Electric Furnace Co., Salem, O., has sold a 200 kilowatt tapping type electric furnace to the United Aluminum Works, Lautewerke, Germany and also has closed with Mitsui & Co., Japan, for a complete heat-treating installation for forgings. Recent purchases of melting furnaces from the same company include the American Bushings Corp., Port Huron, Mich., and P. and F. Corbin, New Britain, Conn. Shaffs Foundry, New Orleans has purchased a 1-ton crane from the Northern Engineering Works, Detroit. The Dayton Steel Foundry Co., Dayton, O., is installing a 2-compartment, oil-fired core oven built by Young Brothers Co., Detroit. The Fox Furnace Co., Elyria, is inquiring for tumbling barrels.

Pittsburgh Shows Activity

SALES of foundry equipment in the Pittsburgh district continue to be recorded from time to time, although recently these have decreased possibly due to the combined effect of the coal and railroad strikes. However, inquiries are plentiful, for practically all types of foundry equipment, small and large. A few orders for molding machines, orders for two or three core oven cars, one or two orders for sand machinery, several orders for small ladles, together with a liberal sprinkling of standard smaller equipment such as flasks, riddles and kindred supplies, are the features of the mid-July market. Recent molding machine purchasers, according to the Herman Pneumatic Machine Co., include the Field Force Pump Co., Elmira, N. Y., a rollover machine; and the United States Cast Iron Pipe & Foundry Co., two jarring machines for its Chattanooga, Tenn., plant. The latter company has not completed the purchase of its molding machine requirements. The American Steel Co., Youngstown, O., is in the market for a large cupola for its new plant at Warren, O. One or two other cupola inquiries are before the Pittsburgh trade and one or two core oven propositions also are pending. Brass foundry equipment is expected to be bought soon by Orr & Sembower, Inc., Millmont, Pa., as the result of a recent fire. Crane and hoist inquiries have been particularly numerous from foundry sources of late, one of the largest being that of the Frick Co., Waynesboro, Pa., producer of refrigerating machinery, calling for two 5-ton, one each 10-ton and 25-ton cranes. Other foundry equipment likewise is to be purchased. The Monitor Bi-Loop Radiator Co., Lancaster, Pa., closed with the Northern Engineering Works, Detroit, on three 5-ton and one 15-ton crane for its foundry and the Wheeling Bronze Casting Co., Wheeling, W. Va., awarded the Shepard Electric Crane & Hoist Co., Montour Falls, N. Y., one 2-ton, 3-motor, 41-foot span crane. The Shepard company also booked one 3-ton electric hoist for the Garford Foundries, Inc., Elyria, O., and an additional order for two 2-ton hoists for the Marion Machine, Foundry & Supply Co., Scottdale, Pa., as well as several of its smaller hoists through the Beckwith Machinery Co., for various foundry interests. The Oil Well Supply Co., Oil City, Pa., recently awarded Pawling & Harnischfeger Co., an order for another 10-ton crane.

Demand Strong In Chicago District

DESPITE strike conditions, the demand for foundry equipment throughout Indiana, Illinois, Michigan and Ohio continues strong. The Ford Motor Co., Detroit has purchased eight large roll over, molding machines from Henry E. Pridmore, Chicago, and 15 crane ladles, each of 1500 pounds capacity from the Whiting Corp., Harvey, Ill. The same interest has sold a 10-ton crane to the Richardson-Phenix Co., Milwaukee, a cupola to the Hance Foundry Co., Westerville, O., and 11 special tumblers to the T. H. Symington Co., Rochester, N. Y. New foundry projects again are figuring in foundry equipment demand. The Bucyrus Co., South Milwaukee, Wis. is constructing a new gray iron foundry and is enlarging its steel and brass foundries. The Chicago Hardware Foundry Co., Chicago is making extensions and additions. Frank D. Chase, Inc., Chicago, has prepared plans for a new foundry and machine shop at Lancaster, Pa. for the Burnham Boiler Corp., Irvington, N. Y. The Pullman Co., Chicago is contemplating the construction of a new car wheel foundry at Michigan City or Pullman. Frank D. Chase, Inc., is engineer in charge. The Maynard Electric Steel Casting Co., Milwaukee, is constructing an addition to its molding and core making departments.

Lighter Inquiry In The East

BUYING of foundry equipment, while lighter this month than in June, continues in fair volume. The Meeker Union Foundry Co., Norwalk, Conn., whose plant recently was badly damaged by fire, is buying equipment for a new plant including a 5-ton electric overhead crane, placed with the Shepard Electric Crane & Hoist Co., Montour Falls, N. Y. The M. W. Kellogg Co., Jersey City, also is buying equipment for a new foundry. Recently this company closed on a 10-ton crane from the Niles-Bement-Pond Co., this order following one a couple of weeks before for 8 electric overhead cranes. Included among other buyers are the Leesport Furnace & Foundry Co. recently organized to manufacture soil pipe in Leesport, Pa., and the Federal Foundry Co., which is occupying the plant of the Garwood Iron & Bronze Co., Garwood, N. J. Among the purchases of the latter was a 400-foot monorail system awarded the New Jersey Foundry & Machine Co., 90 West street, New York. The Titan Iron & Steel Co., Newark, N. J., is going to install three 60-inch continuous cupolas to supply hot iron to its mechanical puddling furnaces, but contemplates building these cupolas itself. The Frick Co., Waynesboro, Pa., which recently closed on 800 tons of structural steel for a new foundry, has purchased, among other equipment, four electrical overhead cranes, as follows: One 25-ton, 4-motor crane, 25-foot span, from the Shepard Electric Crane & Hoist Co., Montour Falls, N. Y.; one 10-ton crane, 74-foot span, and two 5-ton cranes with 35-foot span, for Maris Bros., Philadelphia. The Oneonta

Iron Works, Inc., Oneonta, N. Y., is inquiring for a 5-ton electric crane with 36-foot, 6-inch span. The Garber Machine Co., Bay City, Mich., is inquiring for equipment, including core ovens, ladles and a cupola fan. The Rockford Malleable Iron Works, Rockford, Ill., and the Ft. Wayne Tank & Pump Co., Ft. Wayne, Ind., it is understood, will both be in the market shortly for equipment. The N. & G. Taylor Co., building a foundry at Cumberland, Md., is buying equipment and the Bolivar Foundry Co., Inc., Bolivar, N. Y., has been a recent buyer. Another buyer has been the Baltimore Car & Foundry Co., which has closed on a 1-ton car hauling winch to the Shepard Electric Crane & Hoist Co. A seller in the New York district reports the sale of sand cutters to the Stockham Pipe & Fittings Co., Birmingham, Ala., and E. H. Bardes Range & Foundry Co., Cincinnati. The Westinghouse Electric & Mfg. Co., South Philadelphia, Pa., recently has purchased 48 flasks. Sand blast equipment is said to be moving slowly. Prices generally are unchanged. Cleaning room sundries are moving freely. The Mutual Equipment Co., 251 Fort Washington avenue, New York has sold sand blast barrels to Keubler Foundries, Inc., Easton, Pa.; Louis Sacks Iron Foundry, Newark, N. J.; and the American Chain Co., York Pa. The same company reports active inquiry and sales of tumbling mills, having sold two mills to the Taylor Co., Brooklyn and one each to the New Jersey Spring & Wire Co., Hoboken, N. J., and W. R. Hughes & Co., Inc., New York.

What the Foundries Are Doing

Activities of the Gray Iron, Malleable, Steel and Brass Shops

The plant of the Lorain Steel Casting Co., Lorain, O., recently was damaged by fire.

The F. W. Wakefield Brass Co., Vermillion, O., is erecting an addition to its plant, 38 x 50 feet.

The plant of the Acme Pattern Works, Tacoma, Wash., recently was damaged by fire.

The brass foundry of the Chantrell Tool Works, Reading, Pa., recently was damaged by fire.

The Charles B. Bohn Foundry Co., 3651 Hart street, Detroit, is reported planning the erection of a plant building, 1-story, 46 x 60 feet.

Plans are being prepared by Frank D. Chase, Inc., Chicago, for the erection of an addition to the plant of the Delta Star Electric Co., Chicago.

The Tulsa Stove & Foundry Co., Sand Springs, Okla., is reported planning the erection of an addition to its plant, 80 x 200 feet.

The new foundry of the Rothwell Bros. Foundry, Swansea, Mass., is making a specialty of gray iron castings, etc.

The plant of the National Malleable Castings Co., at Indianapolis, recently was damaged by fire.

Capitalized at $1000 the Foundry Device Co., Dallas, Tex., recently was incorporated by J. A. Smitham, Lydia Levy and P. G. Meyer.

The capital stock of the Alloy Electrical Steel Casting Co., Warren, O., recently was increased from $150,000 to $450,000.

A foundry is to be established at Temple, Pa., by a new company now being organized by S. S. Staley, and others.

Seeds & Steinmetz, Philadelphia, have been awarded the contract to erect a foundry for Thomas Savill & Sons.

The Doehler Die Casting Co., Brooklyn, N. Y., recently increased its capital stock from $1,500,000 to $2,000,000.

Erection of an addition to the foundry plant of the H. B. Smith Mfg. Co., Westfield, Mass., is under the supervision of Frank D. Chase, Inc., engineer, Chicago.

Plans are being prepared by Frank D. Chase, Inc., Chicago, for the erection of a foundry and machine shop at Lancaster, Pa., for the Burnham Boiler Corp., Irvington, N. Y.

Capitalized at $50,000, the Lauchly Foundry Machine Co., Jackson, Miss., recently was incorporated by B. W. Lauchly, W. A. Scott, H. K. Stringer, and others.

A charter has been granted to the Meyer Furnace & Supply Co., 170-174 Reed street, Milwaukee. The company is capitalized at $50,000 and the incorporators are H. L. Jackson, Donald Howland and F. W. Giese. The company will manufacture and deal in heating devices and appliances.

Capitalized at $50,000 the Branford Brass Foundry Co., Branford, Conn., recently was incorporated by Frederick A. Ells, Albert V. Neilson and Hugh A. Cox.

W. W. Rosebraugh, Salem, Oreg., whose foundry and boiler works recently was damaged by fire, plans to erect a temporary plant on the site of the former works.

The Tennan Steel Casting Co., Seattle, has leased the site and buildings formerly occupied by the Aurora Foundry Co. and will specialize in the manufacture of steel castings of all kinds.

A new gray iron foundry is being built under the direction of Frank D. Chase, Inc., Chicago, for the Bucyrus Co., South Milwaukee, Wis. In addition the Bucyrus Co. is remodeling its steel and brass foundries.

Robert P. O'Brien, who operates a pattern works at 86 Calverly street, Providence, R. I., has added a brass foundry which now is in operation. He makes wood and metal patterns and brass, bronze and aluminum castings.

Frank D. Chase, Inc., Chicago, engineer, is in charge of construction of alterations and additions to the North Chicago plant of the Chicago Hardware Foundry Co., which include a new foundry unit and an enlarged coremaking department.

The N. & G. Taylor Co., 300 Chestnut street, Philadelphia, has awarded a contract for the erection of a foundry building, 1-story, 50 x 90 feet, and a general manufacturing building, 75 x 140 feet.

Plans are being prepared by the Meeker Union Foundry Co., Norwalk, Conn., manufacturer of stove castings, for plant to replace one which was recently damaged by fire. It is estimated the new building will cost approximately $50,000.

The Guy Steel Castings Co., West Hartford, Conn., which was incorporated July 7 with a capital stock of $50,000, has been organized with the following officers: President, John A. Guy; vice president, John E. Sinnott; treasurer, W. R. Bennet, and secretary, George B. Kinghorn.

Capitalized at $15,000 the Chicago Sashweight Corp., 322, 155 North Clark street, Chicago, recently was incorporated by William S. Newburger, Maurice C. Bandelman and James Cronin. The company is represented by Julius C. Greenbaum, 322, 165 North Clark street.

Recently the George Fuller Sons Iron Foundry, Hallowell, Me., was purchased by E. L. Gedney, of Augusta, Me. The company was incorporated in 1840 and the plant is estimated to be worth approximately $20,000. For many years the company was the largest iron foundry in New England.

The Sterling Ele tric Steel Casting Co., Falling Springs avenue, Centerville, Ill., has been incorporated to manufacture and deal in castings, forgings, etc., by Claude W. Harrell, Raymond O. Shive, George E. Baker, and others. The company is represented by Raymond O. Shive, 1519 Syndicate Trust building, St. Louis.

Capitalized at $5000 the Brumond Bros.-Hufker Foundry, Inc., 4406 West Carroll avenue, Chicago, recently was incorporated by Henry O. Brumond, John Hufker and Elmer G. Brumond. The company is represented by Andrew J. O'Donnell, 32 West Washington street, room 404, Chicago.

An addition, 100 x 120 feet, is being built to the foundry of the Maynard Steel Casting Co., Twenty-second avenue and Kilbourn road, Milwaukee. The extension will increase the molding and coremaking floor capacity about 50 per cent. Accumulation of business has justified the extension, according to officials of the company.

Due to increased demands the Waukesha Foundry Co., Waukesha, Wis., maker of brass and bronze castings, has decided to start work immediately on the erection of additions to its plant which will double its capacity. The present foundry was built in the spring of 1920 and has been in continuous production. Originally the plant served Waukesha and nearby manufacturers, but it is now selling its products in Chicago, Milwaukee, Detroit, Indianapolis and other markets.

Real estate holdings of the Pittsburgh Malleable Iron Co., Pittsburgh, have been disposed of in the Lawrenceville district, Pittsburgh, to the Atlantic Refining Co. The property comprises 7½ acres extending from Fifty-sixth to Fifty-seventh streets, and from the Allegheny river to the Allegheny Valley railroad. The consideration as reported, is $350,000 cash. The property formerly was owned by the General Chemical Co., which sold it a few years ago for $300,000. It is understood the new owner will utilize it as a site for a plant addition.

According to reports from Schlesingerville, Wis., a company to manufacture electric furnace steel which has recently been formed by Milwaukee and Appleton, Wis., interests, has leased the former Rex gray iron foundry and will remodel it, installing electric furnace equipment as soon as the Milwaukee Electric Railway & Light Co. is able to build a power line to that community. The existing transmission lines are not adequate to handle the current required for the

operation of the proposed steel foundry. The identity of the promoters of the company has not been divulged, pending maturity of negotiations.

Idle about a year, the plant of the Hercules Steel Castings Co., 871-891 Robinson avenue, Milwaukee, again is in production. The shop, which makes electric furnace castings, was reopened recently with nearly 300 men, a normal force. Frank E. McIntyre, who retired a year ago as manager and is again with the National Steel Foundries division of the National Brake & Electric Co., Milwaukee, has been succeeded by F. G. Peterson, for five years manager of the foundries of the Bucyrus Co., at South Milwaukee, Wis. John Toole is general foreman. E. B. Gennrich is secretary and treasurer of the company.

New Trade Publications

CRUCIBLE MELTING FURNACES—The W. S. Rockwell Co., New York, has published a 4-page illustrated folder in which stationary and tilting crucible melting furnaces are described and illustrated. These furnaces are adapted for melting aluminum, brass, bronze, copper, gold, nickel, silver and other nonferrous metals.

MECHANICAL STOKERS—The B. F. Sturdevant Co., Hyde Park, Boston, has published a 20-page booklet containing a paper by H. F. Hagan, research engineer for the company, on forced and induced draft with mechanical stokers. This paper was read by Mr. Hagan at the convention of the Stoker Manufacturers' association, Oct. 19, 1921, at Shawnee, Pa. Some interesting and valuable information is given.

PORTABLE FURNACE—The Mayor Fuel-Saving Furnace Co., Cleveland, has published a 4-page illustrated folder in which a portable furnace for drying cores and molds is described and illustrated. The furnace is made in box form and has an outer cast iron casing with some cast iron internal parts. Air from a direct motor-driven fan is forced through the fuel and special air channels in the furnace. The furnace can be worked with coke or coke breeze with a percentage of small coal added. It will also burn fuel oil, producer or natural gas. It can be attached to existing ovens, is easy to control and has numerous advantages in the drying of cores and molds.

CONVEYING MACHINERY—The Link-Belt Co., Chicago, has published a 30-page illustrated booklet describing its conveying machinery for foundries. The first half of the book is devoted almost entirely to illustrations and diagrams, while in the remaining section details are presented covering double stand continuous elevator buckets, malleable iron buckets, carriers, belt conveyors, locomotive cranes, silent chain, and portable loaders.

MILL TYPE LIFTING MAGNET—The Ohio Electric & Controller Co., Cleveland, has issued a folder giving full descriptions and explanations of the use of its lifting magnet. The leaflet is well illustrated with photographs and drawings diagraming the construction of the magnet. Half a dozen new improvements are described in the folder.

CASEMENTS AND DOUBLE-HUNG WINDOWS—David Lupton's Sons Co., Philadelphia, has issued a 40-page illustrated booklet giving detailed descriptions of the various types of steel casements and double-hung windows. A large portion of the book is devoted to drawings clearly illustrating the operation and construction of the two types of windows. In addition two lists of specifications for the company's casements and double-hung windows are given. These lists give in detail the make-up of each type of construction.

CONSTRUCTION MATERIALS AND BUILDING PRODUCTS — David Lupton's Sons Co., Philadelphia, has published a 190-page catalog which gives complete descriptions of its steel products which include pivoted sash, Pond continuous sash, operating device, truss roof design, counterbalanced sash, counterweighted sash, projected sash, apartment and residence windows, double-hung windows, casements, partitions and doors, rolled steel skylights, corrugated wire glass, shelving, bookstacks, auto parts storage, factory equipment, etc. The book is well illustrated both with drawings and photographs showing the operation and construction of the various products. In addition a brief introduction presents two pages of instructive matter on the company's service.

GEAR CUTTING MACHINE—The Newark Gear Cutting Machine Co., Newark, N. J., has published a 24-page illustrated booklet in which a spur and bevel gear cutting machine is described and illustrated. The machine is entirely automatic. It has a tight and loose pulley countershaft on its own base which drives the constant speed driving pulley. This latter runs upon a rigid gray iron sleeve and not upon the shaft itself, thus relieving the shaft of all side strain of the belt pull. All changes of feed and speed are made by means of change gears. The feed screw operates on the draw-cut principle, the thrust bearings being so arranged that the screw is under tension and not compression when feeding or returning the carriage. The power feed can be engaged or disengaged instantly by means of the handle at the feed box. The indexing mechanism is positive. The cutter carriage and slide can be adjusted to an angle of 90 degrees for cutting all gears ranging from spurs, miters, bevels and face gears. A graduated dial gives the amount of the adjustment in thousandths of an inch. Full specifications are given.

BOILERS—The Dover Boiler Works, Dover, N. J., has published a 64-page illustrated booklet in which a detailed description and specifications of the various styles and sizes of boilers which the company manufactures are given. Portable, vertical and stationary boilers are the types described in the booklet. The specifications given are complete.

INDUSTRIAL FURNACES—The Surface Combustion Co., New York, has issued a series of bulletins pertaining to industrial furnaces. One bulletin is devoted to surface combustion low-pressure air-gas inspirators, which are applicable to any gas furnace. A second bulletin is devoted to surface combustion oven furnaces and describes furnaces for the heat treatment of both carbon and high speed steel, etc. A third leaflet is devoted to surface combustion pot-hardening furnaces, a fourth to surface combustion soft metal furnaces, a fifth to surface combustion galvanizing baths, a sixth to surface combustion shipyard furnaces, a seventh to surface combustion rivet heaters, an eighth to surface combustion small forges, and a ninth to surface combustion laboratory furnaces for high temperatures.

ELECTRIC FURNACES—The Electric Furnace Construction Co., Philadelphia, has published a 20-page illustrated booklet in which electric furnaces for melting, refining and superheating iron and steel are described and illustrated. According to the booklet the heat in these furnaces is generated above and below the bath and can be regulated over a wide range. The hearth is at least 20 inches thick. They are suitable for a two-phase or three-phase electric supply and if one arc is broken the other arcs are not affected. The electrode consumption it is said, is reduced through the use of special economizers. A complete detailed description of the furnace is given.

PULVERIZER—The Bonnot Co., Canton O., has published a 12-page illustrated booklet in which pulverizer and air separator equipment is described and illustrated. While the pulverizer originally was designed for the cement industry, it is widely used in many fields the largest being for grinding coal in pulverized coal plants. However, it also is serving steel plants, foundries, smelters, cement mills, etc., grinding lime, limestone, cement, rubber phosphate rock, clay, chemicals, coloring materials, talc, etc. This pulverizer is made in three sizes. It consists mainly of three parts; the base or main frame which houses the grinding chamber and supports the driving and feeding apparatus; and an air separator and exhaust. The complete unit grinds, separates and delivers a finished product, the operation being entirely dustless, according to the booklet.

FOUNDRY FLASKS—A 70-page illustrated booklet has been issued by the Truscon Steel Co., Youngstown, O., in which steel foundry flasks are described and illustrated. The flasks are for use in all types of foundries and are designed for economical production. In addition to the flasks, some general foundry accessories are described including bottom boards, core plates, snap flask bands, snap flask pouring jackets, gaggers and flask pins. A section of the booklet is devoted to describing and illustrating steel platforms and boxes for use on lift trucks, etc.

RADIATION PYROMETERS—Indicating and multi-recording types of radiation pyrometers are described and illustrated in a 16-page booklet recently published by the Thwing Instrument Co., Philadelphia. According to the booklet, this instrument is the quickest known means for measuring temperatures in metallurgical and ceramic operations, in core ovens, furnaces, cement kilns, coke ovens, boiler fire pits, and in measuring local temperatures of dies in the hardening furnace, etc. This pyrometer has two parts. One is a receiving tube which collects the radiations from the hot body on a conical mirror, which in turn concentrates them upon a highly sensitive black thermocouple, and the second, a galvanometer, with wire connections to the thermocouple to measure the current generated in it by the radiations.

SPECIFICATION HANDBOOK—The Truscon Laboratories, Detroit, have just issued a 108-page revised edition of the Architects Specification Handbook. A loose leaf binding makes it adaptable to any system of classification used by the architect or engineer. The book contains complete specifications on water-proofings, damp-proofings and technical coatings.

METAL COATINGS—The Metals Coating Co. of America, 495-497 West Third street, Philadelphia, has issued an 18-page illustrated folder on metal spraying processes. Three methods are described, one in which metal is used in the form of standard gage wire, another in which a powdered metal is substituted in place of the wire, and the third which through a specially constructed rumbling barrel makes it possible to coat in lots of 100 pounds, articles weighing from a fraction of an ounce up to approximately 10 pounds. The folder is well illustrated with photographs and diagrams. Several pages are given over entirely to illustrations showing the various places in which these machines are being used.